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HOW TO FIND THE MEAN EFFECTIVE PRESSURE

Methods Used When Indicator Cards are not Obtainable.

BY C. J. MASON.

The mean effective pressure in the cylinder of a steam engine is—as the name implies—that which is effective in pushing the piston from one end of the cylinder to the other. In most steam engines, the steam supply is cut-off after the piston has travelled a certain portion of its stroke, in consequence of which the pressure continually decreases after cut-off occurs. This decrease of pressure occasions the use of the word "mean" in the phrase "mean effective pressure", because it is the *mean* or *average* effective pressure which we desire to know. The mean effective pressure depends not only upon the initial pressure and the point of cut-off, but upon the back pressure as well. Herein lies the difference between *average* pressure and *effective* pressure. The *average* pressure throughout the stroke in two given engines may be, we will say, 80 pounds per square inch; that is, the average *pushing* pressure, so to speak. But in one engine the *back* pressure is 16 pounds absolute, while in the other, it is 18 pounds absolute. In the first engine referred to, the *mean effective* pressure will be $80 - 16 = 64$ pounds, while in the other it will be $80 - 18 = 62$ pounds.

The best method of determining the mean effective pressure for any given cylinder is to calculate it from an indicator diagram obtained from the cylinder in question. To describe the whole method in detail, so that a person who does not now understand it, could learn to use it, would consume more time and space than can well be afforded at this time, so that it is mentioned only in passing.

Sometimes it is desirous to learn what the mean effective pressure is in any given engine when indicator diagrams are not at hand, and perhaps not obtainable. The following method may be employed in such a case, if the initial pressure is known, the point of cut-off (from which the range of expansion is found), and the back pressure. If the back pressure is not positively known, then it may be assumed according to known conditions. *Absolute* pressures are taken, which means that the pressure of the atmosphere is to be added to the gauge pressure stated. The pressure of the atmosphere varies, but at sea level is usually accepted as 14.7 pounds per square inch. As a matter of convenience, and where extreme accuracy is not required, 15 pounds per square inch are used.

The formula is stated like this:

$$p = P \times \frac{1 + \text{hyp. log. } R}{R} - \text{back pressure},$$

the letters in the formula having the following values:

p = the mean effective pressure per square inch.

P = initial pressure in cylinder.

R = the range of expansion, or the ratio of volume at end of stroke to the volume at the point of cut-off.

The hyperbolic logarithm factor in the formula is found in a table of hyperbolic logarithms found in most engineers' pocket books, one of which, by the way, should be possessed by all engaged in any branch of mechanical and steam engineering. To illustrate the method of using the formula, we will take the following example:

Required the mean effective pressure in the cylinder of an engine, in which the initial pressure absolute is 80 pounds (65 pounds gauge approx.); cut-off occurs at one-quarter stroke, clearance not to be considered, and the back pressure is 3 pounds per square inch absolute.

Cutting-off at one-quarter stroke means four expansions, so that R in the formula becomes for our example 4, and by referring to the table, the hyperbolic logarithm of 4 is 1.386; so the complete statement appears thus:

$$p = 80 \times \frac{1 + 1.386}{4} - 3$$

$$= \frac{1 + 1.386 \times 80}{4}$$

$$= 47.72$$

and, $47.72 - 3 = 44.72$ mean effective pressure. This is the theoretical mean effective pressure. In actual practice the mean effective pressure would be less than this, because of radiation and condensation losses which occur. These losses cannot very well be allowed for, unless a test were made to determine such loss, and of course, the loss would not be the same for all engines.

When the back pressure is not known, the formula may be used by assuming that for non-condensing engines the back

pressure is 16 pounds absolute, and for condensing engines from 2 to 3 pounds absolute. There is nothing difficult about the formula and its application, excepting perhaps the finding of the hyperbolic logarithm, but even this is not really difficult and the formula is not hard to remember. For the convenience of those who might like to use it, and who have not access to a table of hyperbolic logarithms, the following points of cut-off with the hyperbolic logarithm to use for each is given.

Cut-off.	Ratio of Expansion.	Hyp. Log. R.
¾ stroke	1 1/3	0.262
½ "	2	0.693
1/3 "	3	1.098
¼ "	4	1.386
1/5 "	5	1.600

If a candidate is preparing for an examination he could easily commit to memory these five factors and use them in their respective places. It is not at all necessary that he understand the derivation of the formula, for that requires considerable knowledge of a somewhat different order from that required by operating engineers. Sufficient it is that the formula has been devised and found sufficiently correct for ordinary purposes, and it remains only for us to use it.

There is another method of finding the mean effective pressure that may be of interest to the readers of THE PRACTICAL ENGINEER. It is very simple, easy to remember, and sufficiently close in its results to merit attention.

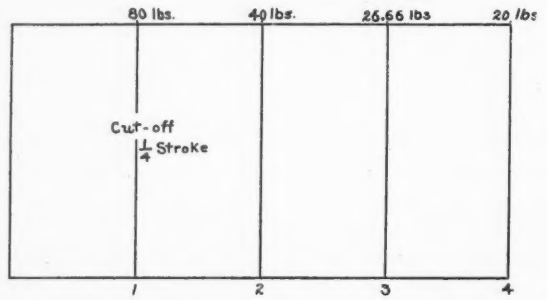


Diagram employed for finding Mean Effective Pressure in Engine Cylinders

A plain rectangular diagram like that shown in the illustration, represents the cylinder of the engine. The figures at the bottom of the diagram represent the different parts of the piston's stroke. The figures at the top of the diagram represent the pressures at the different parts of the stroke. Using the same example as before, the way the pressures are found is like this: As the steam is cut off at one-quarter stroke, we divide the diagram into four equal parts, as shown. If greater accuracy is desired, the diagram may be divided into 8, 12, or even 16 equal parts by vertical lines just in the same manner as our figure now is, we simply use four divisions for the sake of brevity, for the method of operation is exactly the same.

Up to division numbered 1, the pressure is 80 pounds absolute per square inch; at division 2 we say ½ of 80 equals 40, which is the pressure at midstroke. At division 3 we say 1/3 of 80 equals 26.66 pounds, and at division 4 we say ¼ of 80 equals 20 pounds, which is the pressure at the end of the stroke, or in other words, the terminal pressure. It makes no difference what the point of cut-off is, the operation is just the same. The figure at the bottom of the vertical line where cut-off takes place is always taken as the numerator of the fraction, and all the succeeding figures as denominators. The pressure up to the point of cut-off is the remaining factor in the operation. After the pressures for the various points have been found, then the sum total is divided by the number of parts into which the figure has been divided. This gives the mean, or average pushing pressure on the piston throughout the stroke. From this must be subtracted the back pressure. In our example the sum total of the pressures 80, 40, 26.66, and 20 equals 166.66; and this divided by 4 equals 41.66 pounds average pressure, from which is to be subtracted the 3 pounds back pressure, leaving 38.66 pounds as the mean effective pressure.

It will be remembered that with the other method the mean effective pressure was found to be 44.72 pounds, and if we had divided our diagram into a greater number of parts, we would probably have obtained a higher mean effective pressure than 38.66 pounds. This, to a certain extent at least, explains the difference between the results obtained. But aside from this, it could hardly be expected that exactly the same result would be obtained when employing two or more different methods of operation.

Let the interested reader try the same example as we have chosen, only, instead of dividing the diagram into four parts, divide it into say twelve parts, and he will find that there will be but a small difference between the results obtained from the two methods with which we have been dealing.

Impulse and Reaction Steam Turbines.

Steam turbines may be divided into two general types according to their method of utilizing the energy in the steam; namely "impulse" and "reaction."

In the impulse type the steam, before doing any useful work, is expanded in nozzles of various shapes, its pressure being considerably reduced while it acquires a high velocity before acting upon the revolving buckets or blades. In some conconstructions there is only one row or ring of revolving buckets and the turbine runs at a very high speed proportionate to that of the steam, thus necessitating the employment of gearing to reduce the speed to workable limits. In other constructions two or more rows of buckets are used, each of which rows absorbs a part of the high steam velocity, thereby reducing the turbine speed. For the purpose of obtaining a better economy, in the newer impulse turbines the steam is passed through several successive sets of nozzles and their subsequent rows of buckets, necessitating a very careful adjustment of the pressures and velocities by the accurate proportioning of nozzles, buckets and turbine speed.

In the reaction type the steam acts directly upon the blades without initial reduction in pressure, except such as may be effected by the governor in securing speed regulation. The steam flows through a large number of rows of blades, alternately stationary and revolving. Guided by the stationary blades upon the revolving ones, the steam expands continuously throughout the length of the turbine, alternately gaining velocity and imparting it to the rows of blades, partly by impulse, but to a greater extent by the reaction as it issues from the revolving blades. There is no violent change in pressure at any time; the reduction seldom exceeds three pounds at any one row of blades, and the velocities are therefore comparatively small.

REVERSING SHAFT GOVERNOR ENGINES *

By W. H. Wakeman.

Directions for reversing slide valve throttling engines, or any other kind in which an eccentric is fastened to the crank shaft, are found in many books and papers, although if some of them were strictly followed the engine would not run in the opposite direction, while others would cause them to revolve, but at a great disadvantage, so far as use of steam is concerned.

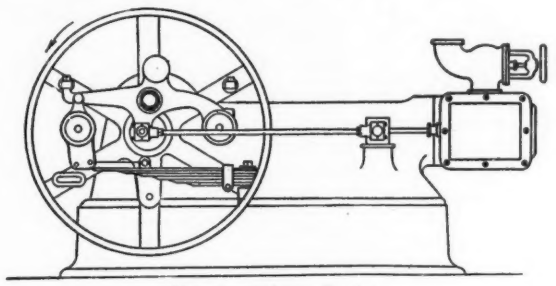


Fig. 1. Skinner Engine

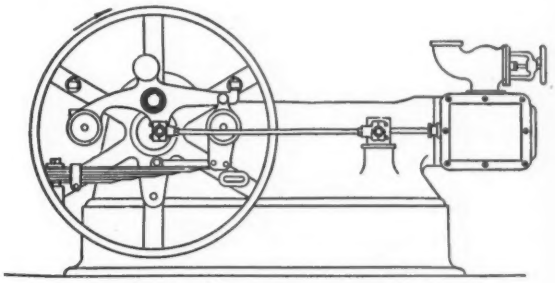


Fig. 2. Skinner Engine Reversed

There are many kinds of engines to which these do not apply, and it is more or less difficult to secure reliable information that will enable an engineer who is not an expert to reverse them, especially if they are of the high-speed, automatic type, with shaft governor. This article was written to supply such information in a plain and practical way.

Fig. 1 illustrates the Skinner engine with governor set to run "over" as indicated by the arrow, or in other words, the top of the fly-wheel travels from the cylinder. This is a left-hand engine because when viewed from a point in front of the cylinder the governor wheel is at the left-hand side. This applies to both direct-connected and belted engines.

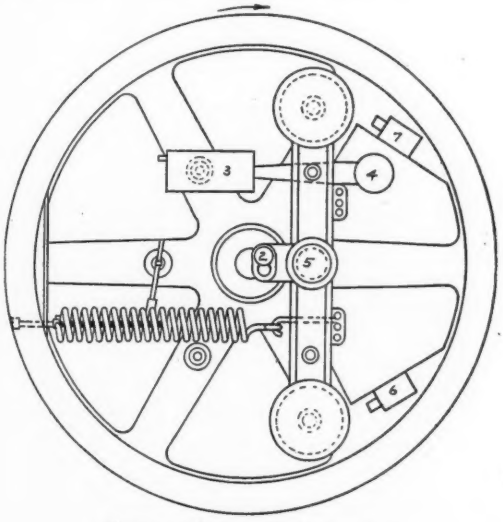


Fig. 3. McEwen Shaft Governor

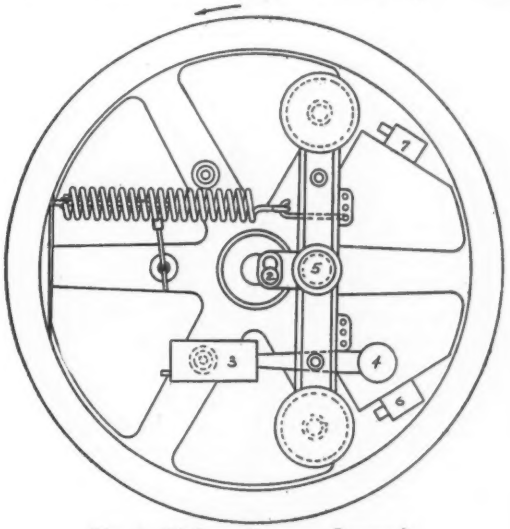


Fig. 4 McEwen Governor Reversed

When it is desired to run this engine in the opposite direction or "under", as shown in Fig. 2, the long-weighted arm must be taken off and turned "end for end" to use a common expression. The heavy six-leaf spring must be turned in the same way.

These two illustrations show the appearance of the governor for both directions of travel, therefore if the engineer in charge of an engine of this kind wishes to reverse it, he can do so by placing the parts as plainly indicated and he can do this without understanding any of the theory of the operation if he has not time enough to study this interesting part of his business.

It will be noted that the wrist pin which carries one end of the valve rod is located to the left of the centre of crank shaft in Fig. 1 and to the right of it in Fig. 2, showing that its relation to the position of crank is changed by the reversing process. As the wheel revolves, this wrist pin describes a circle around the centre of the crank shaft as seen in these illustrations. When the engine is started this circle is comparatively large, giving the longest possible point of cut-off, and it assumes this position whenever a full load is thrown on, but for all lighter loads the circle is smaller accordingly, giving a shorter point of cut-off.

In these two illustrations I have presented outlines of the whole engine in order that the matter may be well understood,

* From The Electricial World.

but this is not necessary in other cases, therefore only the governor in each case will be shown.

Fig. 3 illustrates the McEwen right-hand engine governor set to run "over." The wrist pin is shown at 2 and it will be noted that there is another hole in the arm directly below it; it carefully after the desired change is made.

Another point to be considered in this connection is that in this case and perhaps in others there are two ways of altering the strength of spring. One is to give the coils more or less tension, and the other is to increase or decrease the

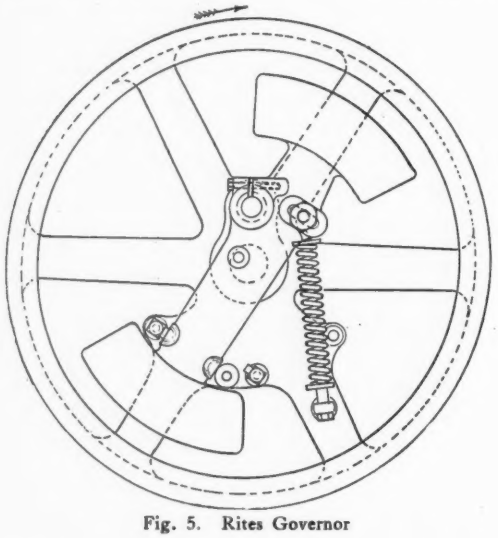


Fig. 5. Rites Governor

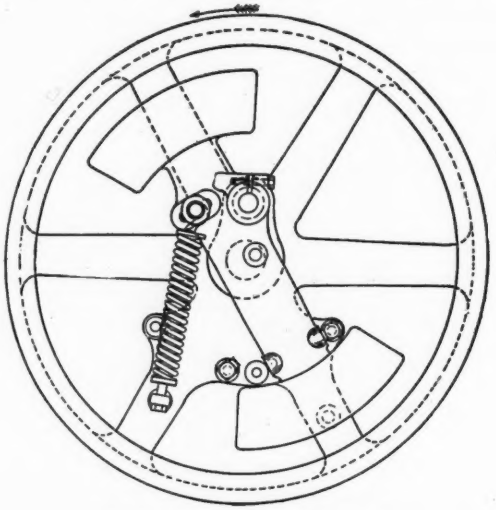


Fig. 6. Rites Governor Reversed

3 is a dash pot, and as centrifugal force interferes with its free operation at high speeds, the weight, 4, is provided to counterbalance it and prevent undue friction. The governor arm is pivoted at 5 and a rubber buffer is provided at 6 for its extreme travel in one direction, and at 7 for the opposite extreme.

Fig. 4 is the same governor set to give motion in the opposite direction. The wrist pin, 2, is now in the other hole provided for it, and all figures refer to the parts mentioned in connection with the preceding illustration.

number of coils in tension by a device not shown in the cuts, but which will be readily seen on the engine.

Fig. 5 illustrates the Rites governor as used on the Watertown engine, when revolving in the direction indicated by the arrow, and Fig. 6 shows the same governor when adjusted to run in the opposite direction. As these governors are used on several high-speed engines it is not practical to mention all of them here, but engineers in charge of any engine controlled by a Rites governor can learn how to reverse it by studying these two illustrations.

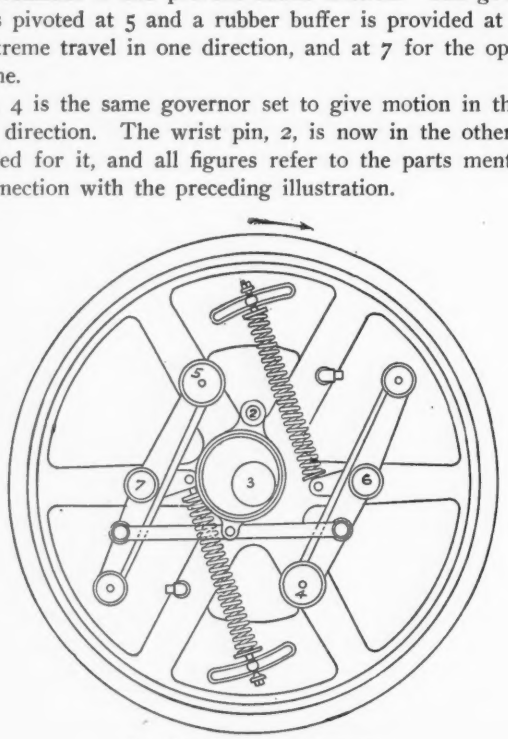


Fig. 7. Harrisburg Governor

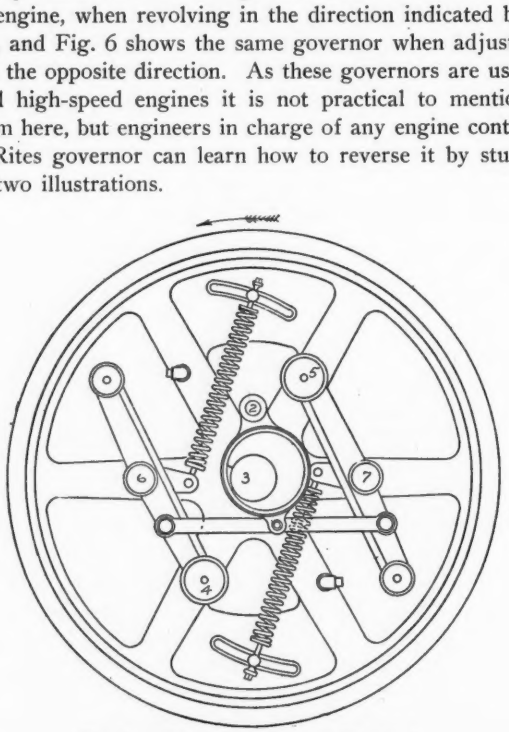


Fig. 8. Harrisburg Governor Reversed

When changing a governor to give a reverse motion, care should be taken to preserve the tension of whatever kind of spring is used. This can be done in the case of a spiral (or more properly speaking, a helical spring), by noting the distance between the coils before disturbing them, and restoring

For illustration, suppose that when one of these engines is compared with the illustrations it agrees in direction of motion and form of adjustment with Fig. 5. If the engine is to be reversed then it must be changed to agree with Fig. 6. To do this it is necessary to take off the governor arm and

turn it over, then change the location of pins which serve as stops, also to change the spring pin which holds the outer end of the helical spring.

It is not practical to state which is for an engine running "over" nor for one traveling "under", but the following rule applies in such cases. An adjustment that is correct for a right-hand engine running "over" will also answer for a left-hand engine running "under."

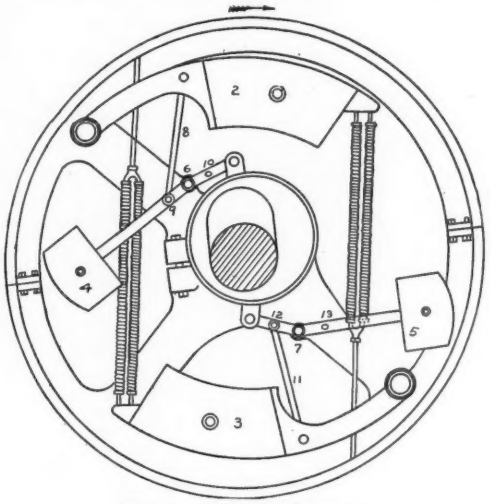


Fig. 9. Fitchburg Governor

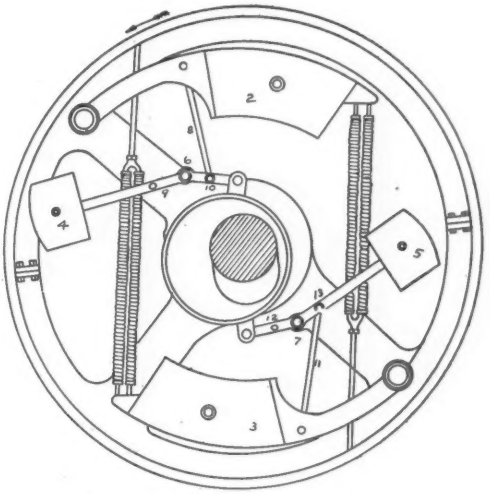


Fig. 10. Fitchburg Governor Reversed

In all engines before mentioned, movement is given to the valve by means of a wrist pin revolving in a circle about the centre of crank shaft. In others the same result is secured by an eccentric that encircles the crank shaft but is neither fitted nor fastened to it. When the load varies, the governor causes this eccentric to swing across the shaft like a pendulum, causing the centre of eccentric to approach or recede from the centre of shaft, as the case may be, thus giving the valve a longer or a shorter stroke, exactly as the wrist pin does on engines already mentioned.

Fig. 7 illustrates a governor of this kind as used on the Harrisburg engine when revolving as indicated by the arrow. The eccentric is pivoted at 2 and swings across the shaft, 3, as described, by action of the weights, 4 and 5, which are pivoted at 6 and 7, respectively.

The action of these weights is opposed by the two helical springs, the outer ends of which are adjusted in slots. After reversing this governor if it does not respond quickly to changes in the load, move the ends of these springs toward the rim of wheel, but if too sensitive move them toward the centre. While these slots are not parallel to any of the spokes, they are inclined sufficiently to make these directions clear.

Fig. 8 is the same governor when set to run in the opposite direction. Numbers refer to the same parts in both illustrations.

Some of the shaft governor engines cannot be reversed, therefore if the flywheel of such an engine must run in the opposite direction for any cause, it is necessary to turn the engine around to secure desired results. The Straight Line engine is a sample of this class. There are others that could be made reversible, but the builders have never considered it necessary to develop this feature. The Erieco engine is an illustration of this kind.

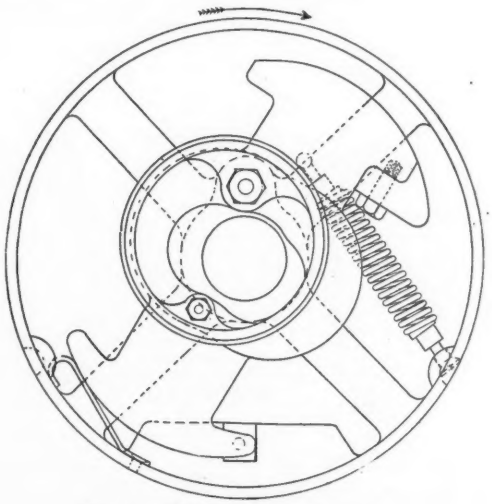


Fig. 11. Modified Rites Governor

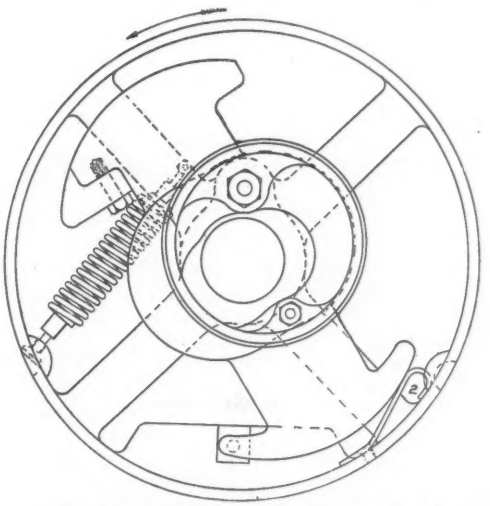


Fig. 12. Modified Rites Governor Reversed

Concerning the need of information that will enable an en-

gineer to reverse an engine, the following incident will serve as an illustration. A certain engine rated at 300 horse power was sold to be removed. When erected in its new position the engineer discovered that it revolved in the wrong direction, as it turned his machinery backward. He decided to

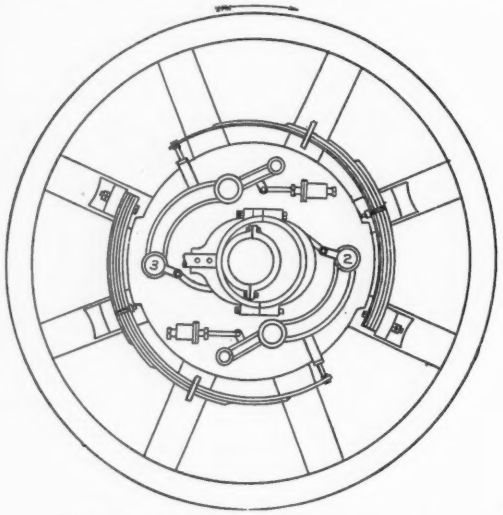


Fig. 13. McIntosh & Seymour Governor

cross the main belt as the only practical way to provide a remedy, but a friend advised him to reverse the engine and he engaged a more competent engineer to do it. Under some conditions an engine looks very awkward when running "under" and there are very few that really operate as well when turning in this direction, but if the main belt on one of this size should be crossed, much extra friction would result in wearing the belt rapidly.

Fig. 9 illustrates the Fitchburg engine governor set to run as indicated by the arrow. While this appears like a complicated piece of mechanism, it really is one of the most simple governors to reverse that is now in use, except that a new eccentric must be substituted. When in the position shown the governor is at rest, and the helical springs draw the heavy weights, 2 and 3, inward, thus raising the eccentric to its highest position, and as this gives the valve its longest possible stroke, steam is admitted for three-quarters stroke of the piston. When revolving, centrifugal force throws the weights, 2 and 3, outward against the force exerted by the helical springs. This forces the eccentric downward across the shaft

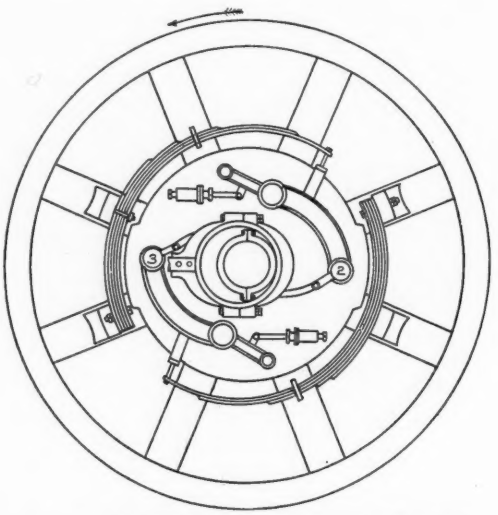


Fig. 14. McIntosh & Seymour Governor Reversed

(which is shown in cross section), until the opposite extreme is reached which almost entirely cuts off supply of steam to the cylinder. Variations in the load will give the governor intermediate position.

The auxiliary weight, 4, operates with the main weight, 2, as it is pivoted at 6, but the other auxiliary weight, 5, operates against the main weight, 3, as it is pivoted at 7, therefore 4 and 5 balance each other, but taken together they resist changes in speed, therefore the result is a very steady speed under varying conditions.

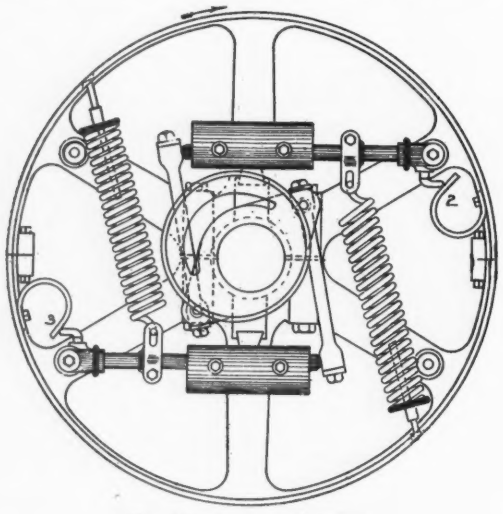


Fig. 15. Buckeye Governor

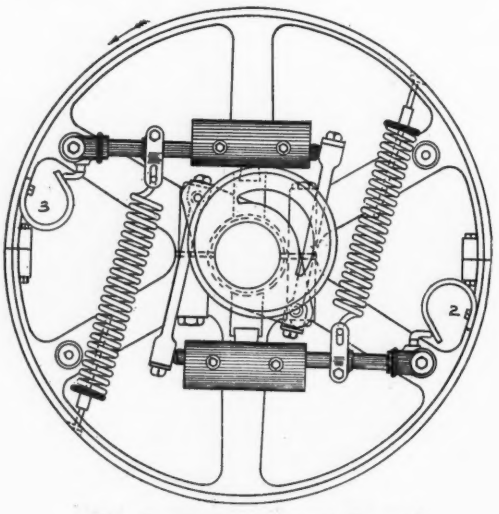


Fig. 16. Buckeye Governor Reversed

Again referring to Fig. 9 if we disconnect the link, 8, from the pin, 9, and connect it at 10 as the weights are thrown outward by centrifugal force, it throws the eccentric in the opposite direction, as it is pivoted at 6. By disconnecting the link, 11, from 12 and connecting it at 13 it also reverses mo-

tion because it is pivoted at 7 and we then have the governor shown in Fig. 10 ready to operate as indicated by the arrow. It is necessary, however, to substitute another eccentric with a different offset.

Fig. 11 is a modification of the Rites governor shown in Fig. 5, both revolving in the same direction, but it carries an eccentric instead of a wrist pin. The latter is used on engines with the governor near the end of crank shaft, and is called an outside connection. The former must be used on engines with the governor between the wheel and the bearing, called an inside connection, but it can also be used on outside connected engines. An eccentric affords more wearing surface, but it travels fast accordingly, creating more friction, and requiring more lubricant to keep it cool. A wrist pin contains less wearing surface, but with first-class lubrication it proves durable because the speed of its surface is much less.

Fig. 12 is the same governor set to revolve in the opposite direction from Fig. 11, or the same as Fig. 6. A buffer spring is shown at 2 which tends to hold the governor steady under sudden changes of load. It is used on the Brownell engine.

The action of governors heretofore shown gives the valve a long stroke for a heavy load and shortens it when a part or all of the load is revolved, but following illustrations show governors that give the valve a constant stroke under all changes. The cut-off is performed by rolling the eccentric forward or backward, as the case may be, to meet changes in load. Of course, the eccentric must be a sliding fit on the shaft for this purpose.

Fig. 13 represents the McIntosh and Seymour governor which belongs to this class. Centrifugal force throws the weights, 2 and 3, outward, thus drawing the eccentric forward or in the direction of motion, and this regulates the amount of steam taken at every stroke. This action is resisted by the two heavy leaf springs shown.

Fig. 14 is the same governor set to revolve in the opposite direction. Centrifugal force tends to adjust the position of eccentric to the load as before, giving very good regulation.

Fig. 15 shows the Buckeye governor, which is claimed to be the pioneer in this line. In this position the two weights are drawn inward as far as possible by the stout helical springs, forcing the eccentric backward on the shaft and giving a long point of cut-off. The auxiliary springs, 2 and 3, are now under full tension and assist in regulating speed. but are in contact only during the first half of the outward movement of the weights. During the latter half of this movement they are not in contact, as greater tension of the main springs, due to elongation of them, renders it unnecessary.

Fig. 16 shows the same governor set to run in the opposite direction. This is accomplished by changing all connections to opposite places, and taking care to set the auxiliary springs as above described. Fig. 17 illustrates the governor used by Clark Bros. to advance or retard the eccentric on the crank shaft. The weights, 2 and 3, are thrown outward by centrifugal force which is opposed by the helical springs. Arms carrying these weights are pivoted at 4 and 5, respectively, and the shaft is shown at 6. A peculiar feature of this governor is the pendulum weight, 7, which is pivoted at the extreme end. It is connected by a link to an arm carrying the weight, 2. As 7 stands at right angles to the crank shaft, it resists any tendency to change its speed very strongly on this account. hence it is valuable in maintaining nearly uniform speed under sudden changes of load.

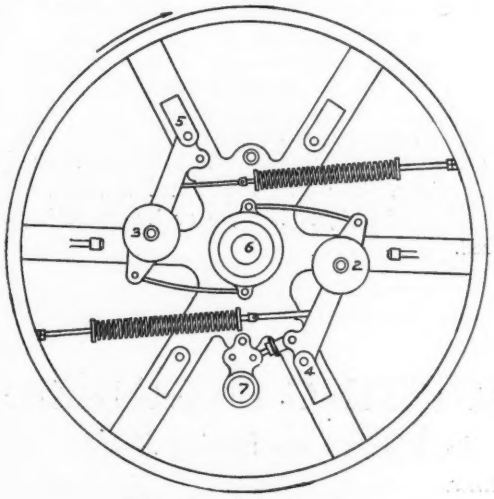
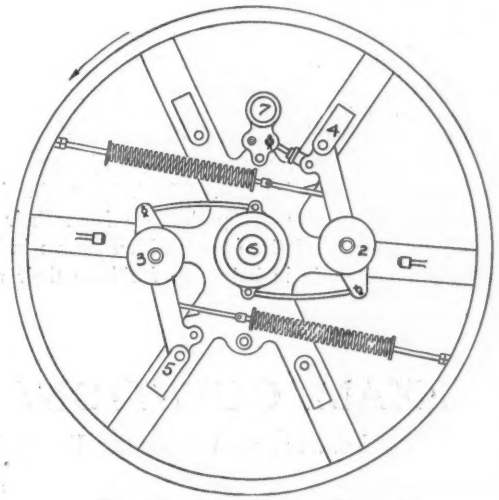


Fig. 17. Clark Governor



Eig. 18 Clark Governor Reversed

Fig. 18 is the same governor revolving in the opposite direction. Of course, all connections are changed, and the pendulum weight is now on the opposite side of the governor.

When reversing this engine or any other on which springs are used care must be taken to give them equal tension, as otherwise more strain will be brought to bear on one side than on the other, producing unsteady motion, and lack of that perfect balance which denotes correct adjustment. This matter was referred to in connection with engines fitted with a wrist pin on the governor, but it needs to be emphasized when describing those fitted with an eccentric, as the greater revolving surface in contact tends to disturb the balance, thus enlarging the effect of any slightly incorrect adjustment.

Fig. 19 is the Russell engine governor for a right-hand engine to run "under" or a left-hand "over." The main eccentric is keyed to the shaft, therefore if it is not well lubricated it cannot turn as when held by a set screw. The key way is cut in the shaft, opposite to the crank before the engine is finished

in the shop, and it is also cut in the eccentric as nearly correct as possible, but it is sometimes necessary to make an offset key to reduce lead when the engine is tested.

To reverse this engine the main eccentric must be turned, and if an offset key is used it must be reversed. The cut-off eccentric must be carried around on the shaft until it has the same relative position in advance of the crank that it had before. It is necessary to reverse the spring connections and weighted arms to accomplish this. The fulcrum pins for these arms must go into holes at 60 degrees from their former places, bringing the whole into the position shown in Fig. 20. The eccentrics are made in halves to facilitate their removal.

In order to get the desired angle of advance for the cut-off eccentric the case containing it must be turned on the shaft until brought to the right place. In cases where the governor is placed in the flywheel, a new key way must be cut, as the wheel must be turned on the shaft.

As shown in these illustrations the weights are in contact with buffers, which they leave as soon as moderate speed develops enough centrifugal force to overcome the action of the helical springs. The arms are slotted to admit of changing the position of weights if more or less centrifugal force is required.

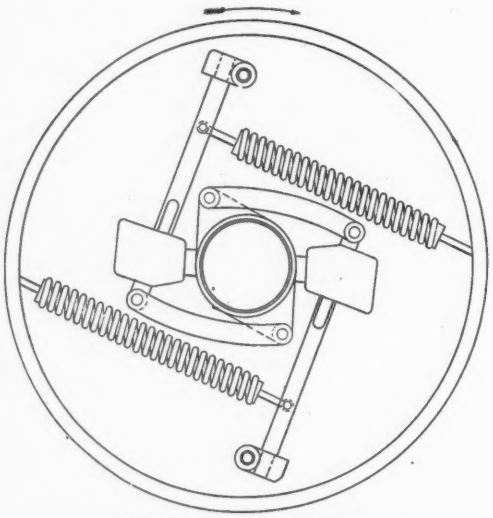


Fig. 19. Russell Governor

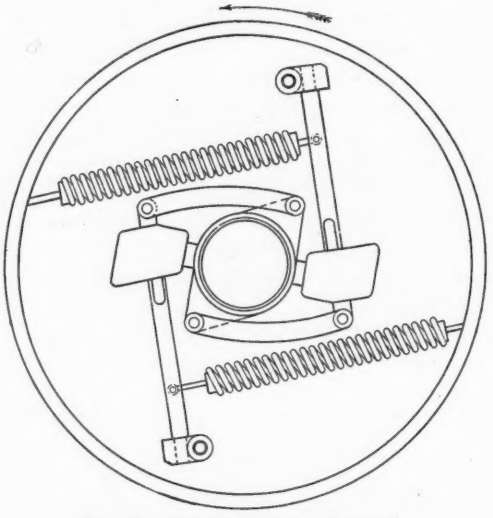


Fig. 20. Russell Governor Reversed

EXAM. QUESTIONS FOR HOISTING ENGINEERS

Answers to Questions Recently Asked by the Illinois State Mining Board

By E. S. Hawkins.

Below will be found answers to some of the questions published by O. F., on page 23 of the August issue. Since the first three and the twelfth questions can be answered by anyone for himself, by consulting the published laws of Illinois, I have not answered them. Beginning with Question 4, the answers are:

Question 4.—How would you prepare a boiler for cleaning?

Answer.—Draw the fires, close the doors and let the boilers cool off gradually, taking care, of course, that there is about the usual amount of water in them. When the boiler is fairly cool and the steam gauge shows no pressure, the top manhole plate is taken off and the water run off at the blow-off connection or pumped into other boilers or the hot well depending on its character and the value of water in the locality where the boilers are used. As soon as the boiler is about empty and in fact while the water is being run off, the hand hole and man hole plates are removed. Care is taken to get as much good air into the boiler as possible so that at the worst there will be no danger on account of poor air, to those entering.

Finally the bottom manhole plate is removed and all the loose sediment taken out. This may mean the carting away of several wheelbarrows of mud if the water is bad or the boiler has not been cleaned as often as desirable. At any rate, the work should be done as quickly and thoroughly as possible. Thoroughness is the prime essential in caring for boilers as well as in almost everything else. Quickness is advisable so that the cleaners can get at the scale on the internal surfaces before it has become cold and set after drying out. Some boiler cleaners have been known to loosen the scale by blowing all the water out of the boiler while under a greater or less pressure of steam. No matter what the steam pressure, this method must always be condemned, since it is evident that the scale can only be loosened by sudden contraction, which is the action that takes place when the water is blown out under pressure. If there is no contraction of the boiler and the resulting leaky seams, there is no loosening effect on the scale. This method cannot be consistently used by anyone except those who have no objection to paying the bills of the boiler maker and the cost of new boilers.

Before entering the boiler, it should be shut off from the

rest of the system by closing all the valves. Of course, it is understood that the boiler must be cut out in the first place. Through neglect of this precaution men have been roasted alive in boilers by steam that entered either through the blow-off connections when another boiler was being blown down, or through the main steam header when another boiler was cut into the system that before was not under pressure. These things can all be prevented by proper care on the part of the employees around the plant, provided men were always infallible and kept their memory, but no one can get steam past the closed valves, no matter how bad his memory.

Before beginning to scale the boiler, the openings at the bottom should be stopped with plugs of soft pine wood, so that no scale can get into the piping system. All these things should be prepared for beforehand and done in less time than it takes to tell it. By this means the men can go into the boilers while the scale is still moist. Use the best implements at hand to remove the scale, as more time and money can be saved by having the proper tools than in any other way. Some of the internal surfaces can be scraped by hand and the scale will shatter off (at least to a certain extent) some of the tubes, if they are tapped (in reason) with a hammer. A number of mechanical cleaning devices on the market can be passed into the tubes and used to shatter off the scale. These work well where the conditions are right and form one of the most rapid methods of getting the scale off.

Some scales are so hard that they seem to resist all such means as this and it is then probably necessary to use some one of the "rotting" materials, such as kerosene. This is conveniently applied by filling the boiler to a level above the scale formation with water and pouring in the oil on the surface of this water. By running the water off, the oil gradually follows and covers all the scale surfaces. If used with proper care this treatment can have little or no injurious effect, but if an excess of oil is used and is not removed with the scale it will attack the metal surfaces. The oil eats into the scale and metal indifferently, since the action in both cases is founded on its permeating qualities. No doubt the action on metals is not so rapid as that in the case of scale, and intelligent management can prevent injury to the boiler.

When the rotting action of the kerosene has softened and disintegrated the scale sufficiently to make possible its removal, this can be effected in the manner already described. When the scaling process is completed, the boiler is washed out thoroughly with a hose, after which all necessary repairs should be made. If the conditions are such that the interial surfaces corrode, the zincs used to prevent this corrosion should be examined to see that they are in good condition and that the contact with the metal is good. In case it is found broken, the surfaces should be filed bright and a fresh contact made, after which the join is covered with cement. If any pitted holes are found they should be cleaned and cemented.

When everything is done, the plugs in the openings in the bottom of the boiler should be removed and all tools used in cleaning should be taken out. The engineer should get into the boiler and make a thorough personal inspection to see that the work is properly done and that all articles are removed, indeed it were all the better if he had been there while the work was going on. Rubber gaskets are used for the hand hole and man hole plates and should be coated with plumbago before being put in place. This precaution makes the subsequent removal of the gaskets easy and saves time, worry and gaskets the next time any work is to be done in the boilers.

Question 5.—We wish you to put us in a boiler, to give us 120 horse power, the boiler to be 16 feet long and 6 feet diameter. If a cylinder, say cylinder; if a flue boiler, say flue; if a tubular boiler, say tubular; give number and size of tubes, number of feet of heating surface, grate-bar surface, kind and size of safety valve.

Answer.—If of the return tubular type, a 16 x 16-foot boiler will contain sixty 4-inch tubes and the heating surface of the shell will be 201.1 square feet, while that of the tubes is 1,005.3 square feet and the total surface is 1,206.4 feet. Allowing 10 square feet of heating surface to the horse power, this means a total of 120.6 horse power, which comes reasonably close to the requirements. The evaporation from and at 212 degrees F. will be 2,653 pounds of water per hour. Allowing 0.33 square foot of grate surface per horse power, the total surface of the grate is 40 square feet. For a gauge pressure of 150 pounds and a consumption of 15 pounds of coal per square foot of grate surface per hour, the diameter of the safety valve should be 3 inches.

Question 6.—We are putting in a pair of compound engines in a mine and we have a steam pressure of 150 lbs. per square inch; our high-pressure cylinder is 20 inches by 28 inches. What size would you have your low-pressure cylinder?

Answer.—With a gauge pressure of 150 pounds, the absolute pressure will be 164.7 pounds and the total number of expansions will be 9.7, while those of the high-pressure cylinder are 3.1 and for the low-pressure cylinder 2.9. In the high-pressure cylinder the terminal absolute pressure is 52 pounds and the terminal drop 2.3 pounds, while for the low-pressure cylinder the similar quantities are 17 and 1.5 respectively. The mean back pressures for the two cylinders respectively are 50.2 and 15.5 pounds absolute, while the mean effective pressures are 60.9 and 19.6 pounds. In the receiver, the pressure is 49.7 pounds. With these assumptions, the ratio of cylinder areas will be 3.1. Since the diameter of the high-pressure cylinder is 20 inches, its area is 314.16 square inches, which, multiplied by the ratio of the cylinders, 3.1, gives 973.896 square inches for the area of the low-pressure cylinder. This corresponds to a diameter of 35.25 inches, so that in practice the cylinder would be made the commercial size of 36 inches.

Question 7.—We are using 12,000 lbs. of coal to do our hoisting and pumping. We are putting water in the boiler at a temperature of 45° F. How much coal will we use if we put water in the boiler at a temperature of 100° F.?

Answer.—To find the amount of heat that must be supplied by the fuel to evaporate 1 pound of water, we have the formula $H - H_1 = 1082 + 0.3\ t - (t_1 - 32)$ in which t is the temperature of the steam and t_1 the temperature of the feed water, while H is the total heat necessary to evaporate the water from a temperature of 32 degrees into steam at 150 pounds pressure, and H_1 is the heat in the feed water. When the feed is at a temperature of 45 degrees, this formula gives 1,178.68 heat units to be supplied by the fuel, while with the feed at 100 degrees, 1,123.68 units must be supplied by the fuel. This is a difference of 55 heat units or the difference in temperature between the feed water in the two cases. Multiplying 55 by 100 and dividing the product by 1,178.68, the result is 4.66 per cent. saving in fuel in the case where the feed is at a tem-

perature of 100 degrees. This, therefore, means a saving of 559.2 pounds of coal out of the 1,200 pounds formerly burned.

Question 8.—What thickness must the steel be in a cylinder boiler to stand a pressure of 140 lbs. per square inch; the boiler to be 48 inches diameter, allowing 1-6 for safety, tensile strength of steel 60,000 lbs. per square inch?

Answer.—Assume that the horizontal seams are double riveted and that the strength of the joints is 70 per cent. of that of the solid plate, while the circumferential seams are single riveted. Suplee gives the formula,

$$P = \frac{T \times B \times t \times 2}{D \times F}$$

Where, D = the diameter of the boiler in inches,
P = the working pressure in pounds per square inch,
t = the thickness in inches,
B = the percentage of strength of joint compared with that of the solid plate,
T = the tensile strength of the material in pounds per square inch.
and, $F = 6$ = the factor of safety.

Substituting the proper figures in the formula, we have $(140 \times 48 \times 6) \div (2 \times 60{,}000 \times 0.7) = t = 0.48$ inch, which is the thickness of the plate to withstand the given pressure.

Question 9.—Give the weight of a cylinder boiler 4 feet diameter, 18 feet long and thickness of steel 1.038 of an inch?

Answer.—It is assumed that this question means to ask for the weight of the cylindrical shell, since the data is sufficient to figure only that part of the weight of the boiler. To find the weight of a cylindrical shell of plate without seams, Hutton gives the *Rule:* Multiply the internal diameter of the shell in feet by its length in feet and by the number of sixteenths of an inch that the shell is thick. This product is then multiplied by the constant 8.01736 and the result will be the weight in pounds. It may be said that this rule is simply an example worked out with unit dimensions for the boiler. To make the correct allowance for the weight of the seams, each particular case must be figured separately, but it is sufficiently accurate to allow one-sixth additional when the seams are riveted as just mentioned or one-fifth additional weight where the boiler has double riveted circumferential seams and treble riveted longitudinal joints. In the case in hand, the rule gives $4 \times 18 \times 16.6 \times 8.01736 = 9{,}582.348$ pounds.

Question 10.—We have a circular tank full of water, the tank is 12 feet diameter on top and 15 feet at the bottom and is 15 feet deep. The water in the tank is 100° F.; how much coal will it take to evaporate the water into steam?

Answer.—A 12-foot circle has an area of 113.1 square feet, while that of a 15-foot circle is 176.71 and the mean of the two is 144.9 feet. This quantity multiplied by the depth, 15 feet, gives 2,173.5 cubic feet, which is the capacity of the tank. Using the same formula as in Question 7, we have, $H - H_1 = 1{,}082 + (0.3 \times 212) - (100 - 32) = 1{,}077.6$ heat units necessary to evaporate 1 pound of water from a temperature of 100 degrees into steam at 212 degrees. At 100 degrees, the weight of a cubic foot of water is 62.02 pounds and the total weight of the 2,173.5 cubic feet of water in the tank is 134,800.47 pounds, which multiplied by 1,077.6 and divided by 14,700, the number of heat units in fair coal, gives 9,881.7 pounds of coal required, disregarding the loss in the boiler or other apparatus used to evaporate the water. When the per cent. of efficiency of the boiler is known, it is a simple matter to increase the amount of coal as necessary.

Question 11.—What is an indicated horse power?

Answer.—An indicated horse power is an amount of work equivalent to 33,000 foot pounds a minute, shown by an indicator to be performed by an engine. In other words, it is the actual work corresponding to the pressure and expansion of the steam in the cylinder and disregarding friction and other losses. If, on the other hand, a brake be applied to the flywheel of an engine until 33,000 foot pounds of work are absorbed a minute, the engine is said to deliver one brake horse power and the indicated horse power to do this would have to be greater than 33,000 foot pounds a minute by the amount ost in the machine itself as friction, etc. To calculate the indicated horse power shown by an indicator diagram, the length of the stroke in feet is multiplied by the mean effective pressure and by the product of the piston area in square inches and the number of strokes a minute. This final product is then divided by 33,000 and the result is the indicated horse power shown by the indicator to be available in the cylinder of the engine—but nowhere else.

Question 12.—With water at a temperature of 40° F., which would you use, a feed pump or an injector?

Answer.—With feed water at a temperature of 40 degrees F., I should use the injector to feed the boiler for the reason that it can handle the water well and will warm it by an amount equivalent to the heat in the live steam used to run the injector. If the pump was used, the water would not be heated to so great an extent before entering the boiler unless it was sent through a heater.

Question 14.—Give the breaking strain of ⅞ steel wire rope.

Answer.—Pliable hoisting rope made of six strands of nineteen steel wires each, and known to the trade as number 9, has a diameter of ⅞ inch and a circumference of 2¾ inches, while the weight is 1.2 pounds per foot of length and the breaking strain 11.5 tons of 2,000 pounds each.

Question 15.—We have a lodge which is 26 feet long, 8.5 feet wide and 7.5 feet deep. The lodge is full of water. How long will it take a 4-inch pump, having a velocity of 100 feet per minute, to empty lodge? We have two 2-inch pipes running full in the lodge at a velocity of 100 feet per minute each. Resistance of pump 10 per cent.

Answer.—This question is not clear, as I cannot tell just how the two 2-inch pipes are used. Otherwise, the question is the simple problem of figuring the cubic contents of the lodge and the amount of this that the pump delivers per minute. From this the time to empty the lodge is found. If the two pipes mentioned bring more water into the lodge, the time will be proportionately increased before emptying is completed.

———o———

The horse power exerted by an ammonia compressor depends upon the head pressure and back pressure, but in general it requires 2 horse power per ton of refrigerating capacity for machines less than 10 tons capacity, 1½ horse power per ton for machines up to 50 horse power capacity and 1¼ horse power per ton for larger machines.

———o———

To find the capacity of any tank in gallons, multiply the area of end in square inches by the length in inches and by .0034. The result will be U. S. gallons.

ELEMENTARY ELECTRIC ENGINEERING

Saturation or Magnetization Curve

By Jacob Glogan.

Part II.

The magnetization or saturation curve shows the magnetic conditions of the magnetic circuits as a whole from zero to maximum magnetization.

This magnetization is produced by the ampere turns of the field windings, the number of ampere turns being obtained by multiplying the number of turns on the field by the number

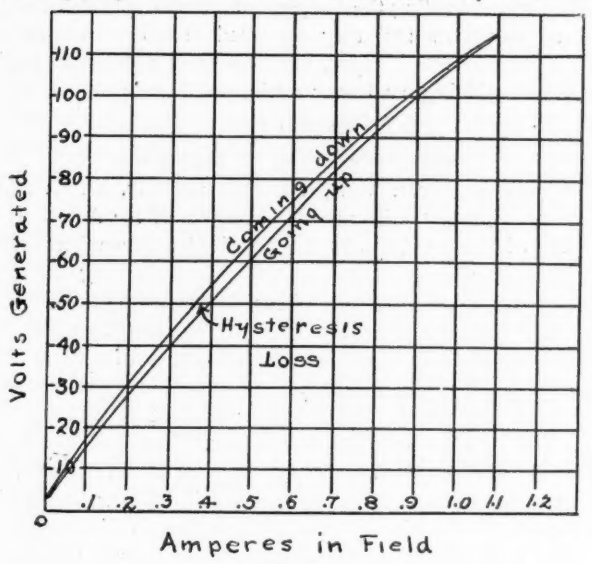


Fig. 1

of amperes passing through them. This force, which is called the magneto-motive force, acts upon the reluctance of the magnetic circuit and produces what is known as the magnetic flux. The electro-motive force of a dynamo depends upon the flow of this flux through the armature and is generated by rotating the coils on the armature through a varying magnetic field.

The materials used in these magnetic circuits have the property of becoming magnetically saturated, that is, the density of the flux becomes so great that it is very difficult to increase it without more than proportionately increasing the magneto-motive force, or, in other words, by increasing the number of ampere-turns on the fields. When the increase in magneto-motive force no longer increases the density of the flux through the magnetic circuit, the material is said to have reached its saturation point. If this were not so, the flux might go on indefinitely increasing with the magneto-motive force.

The main object of finding a magnetization curve is to show at what time the machine should be operated to produce the best regulation of the electro-motive force with the least expenditure of copper wire or electric energy.

The law of the magnetic circuit can then be stated as follows:

$$\text{Magnetic Flux} = \frac{\text{Magneto-motive force}}{\text{Reluctance}}$$

The magneto-motive force being produced by the number of ampere turns on the field, it can easily be calculated that the magneto-motive force of a coil is equal to 1.257 times the ampere turns.

The reluctance of the circuit depends upon what kind of material and the degree of saturation. This reluctance is generally made up of a number of reluctances in series. In a dynamo, it consists of the field poles, the yoke, the armature and the air space between the armature and field. The magnetic flux flowing through the circuit, therefore, follows the same law as that of a current flowing through a circuit.

A magnetization curve of a dynamo is made by varying the voltage from zero to maximum and from maximum to zero. In plotting the values between volts generated and amperes in field, it will be found that there will be two curves, one obtained in going from zero to maximum and the other obtained in going from maximum to zero. This is due to the hysteresis which is inherent in all magnetic circuits and is caused by the magnetic retentiveness of the materials. An average magnetization curve is shown in the accompanying diagram, Fig. 1. The connections are made as shown in Fig. 2.

The method for finding the curve is as follows: The machine is started and no exciting current is allowed to flow through the shunt field. The voltmeter will probably indicate about 4 or 5 volts due to the residual magnetism. Now allow the current to flow through the fields and increase it gradually

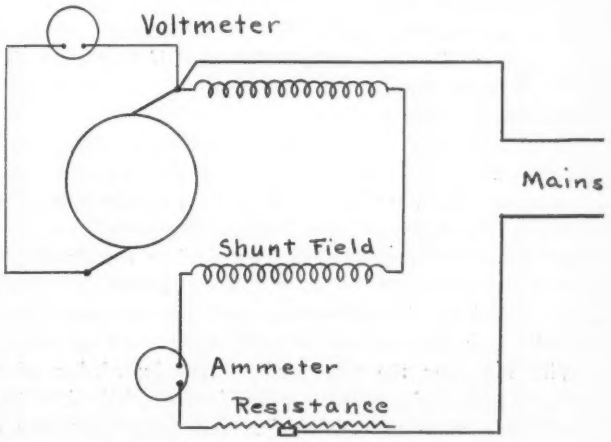


Fig. 2

until you reach the maximum. Take the voltmeter readings at every change of current in the fields, being sure that the machine is being operated at constant speed. After this is done, diminish the current in steps in the field and again take the corresponding values of the voltage.

When all the readings are obtained, take a piece of cross-section or curve paper and plot out the results, using amperes flowing in the field as ordinates and the voltage generated as abscissae.

To illustrate how the curve in Fig. 1 was obtained, suppose the figures obtained were as follows:

Amperes in Field.		Voltage Generated.	
up.	down.	up.	down.
.0	1.0	3.5	112
.1	.9	17.0	102
.2	.8	25.2	95
.3	.7	37	85
.4	.6	46.7	76
.5	.5	59.2	65
.6	.4	75	55
.7	.3	81	45
.8	.2	91	34
.9	.1	100	22
1.0	.0	108.7	3.5

After the values are laid out on the curve paper, draw the curves through them as near as possible without changing the direction of the curve. The result will be as shown in Fig. 1.

Recent Discoveries Prove that Steam Engines were Used in Egypt 3,000 Years Ago.

Watts, the English inventor, is generally credited with the first practical utilization of steam as a motive power, thereby depriving the ancient Egyptians of an honor which properly belongs to them. For the expert engineers who constructed pyramids and other wonderful temples, thousands of years ago, actually knew a great deal about the power possibilities of steam and compressed air and knew how to apply them, too, in a very astonishing manner.

In a very interesting little volume by Henry Ridgely Evans, on "The Old and the New Magis," just issued by the Open Court Publishing Company, Chicago, the details are given of several most ingenious mechanical appliances operated in Egypt 3,000 years ago.

There was a great deal of mystery about some of the engines of those days, so much, in fact, that if they were set in operation today they would undoubtedly puzzle most people, even in these enlightened times.

Try to solve the mystery of this ancient engine, for instance: Near the front of one of the temples an altar was erected. A few minutes after the altar was lighted the temple doors would open slowly by some invisible means and remain open just as long as the fire was kept burning. When the flames died down and finally expired the temple doors would slowly swing in again and remain tightly shut until the altar fire was relighted, when the mechanical performance was repeated.

With not even the most rudimentary knowledge of the forces of heat and expansion to guide them, it is little to be wondered at that the people of ancient Egypt regarded the mystery of the altar fire and the temple doors with reverential wonder.

The altar was hollow, and when the fire was lighted, the air in the interior expanded and sought escape down a pipe leading to a globe beneath filled with water. The pressure of the air on the water in the globe forced the water in its turn to seek an exit. The ancient Egyptian engineers provided this in the form of a bent tube leading from the top of the globe to a bucket into which the water fell. The bucket was suspended upon a cord which passed along two vertical rollers forming the prolongation of the axes upon which the temple doors above turned. As the bucket began to fill with water the extra weight increased the strain on the pulley ropes which in their turn operated the rollers and caused the temple doors to swing slowly open.

When the altar fire died down the temple doors closed themselves in the following equally ingenious manner. The bent tube connecting the globe and bucket formed a siphon, the longest branch of which was plunged into the globe. As the fire was gradually extinguished, the air contained in the body of the altar and in the globe began to cool and to diminish in volume. This act of contraction sucked up the water from the bucket back through the tube into the globe. As the bucket emptied and became lighter it released the strain upon the pulley ropes, holding the temple doors open. A counterweight closed the doors and they remained closed until somebody lighted the altar fire again, when the very mysterious performance would begin all over again.

Self-Synchronizing of Alternators.

A paper by Prof. Morgan Brooks and Mr. M. K. Akers, read at the recent Milwaukee Convention of the American Institute of Electrical Engineers, described a convenient method of placing alternators in parallel without causing the circulating current to exceed a certain desirable limit. Instead of directly closing the switch between two machines and thus subjecting them to a possible impulsive rush of current if the machines are not in the proper phase positions and revolving at the proper speeds, an inductance without an iron core was inserted between the two alternators. The inductance prevented a dangerous rush of current even at maximum difference of phase, and yet the current which did flow produced an adequate synchronizing force to draw the machines into step.

The experiments were conducted with 60-cycle current and the results were very satisfactory. The circuit between the machines could be closed while the machine to be brought into step was at a standstill; when the speed was approximately synchronous, it would automatically fall into step, after which the excitation could be adjusted and the inductance cut out.

In the case of a synchronous converter, started from the direct-current side, the use of coreless inductance to permit the closing of the connecting switch at any instant was sometimes found to cause the converter to race as a direct-current motor, owing to the weakening of its field, and consequent increase of armature current. This objectionable tendency was overcome by the use of a second inductance connected in series with the direct-current armature and additional to the starting box.

Capacity of Fans.

The capacity of fans, expressed in cubic feet of air delivered per minute, is equal to the cube of the diameter of the fan-wheel in feet multiplied by the number of revolutions, multiplied by a coefficient having the following approximate value:

For fan with single inlet delivering air without pressure, 0.6; delivering air with pressure of one inch, 0.5; delivering air with pressure of one ounce, 0.4. For fans with double inlets the coefficient should be increased about 50 per cent. For practical purposes of ventilation the capacity of a fan in cubic feet per revolution would equal 0.4 the cube of the diameter in feet.

THE APPLICATIONS OF SUPERHEATED STEAM

1,000,000 Horse Power Installed During the Past Five Years

At the recent meeting of the National Association of Steam Engineers, at Philadelphia, Mr. E. H. Foster read an interesting paper upon the application of superheaters. He showed the necessity for superheat in many plants and explained the reasons why European practice is ahead of this country in the use of the superheater. His paper follows:

"That the superheater forms not only an important but a necessary part of the equipment of a modern steam plant will be denied by very few engineers who have kept themselves posted on current practice.

"It is no longer necessary to explain, when speaking in public on this subject, what superheated steam really is. Of course, we all know that the temperature of superheated steam, which is allowed to expand, bears no relation to the pressure and that it would be quite possible to heat steam at 100 pounds pressure or at one pound pressure to a temperature of 1000 degrees Fahr.

"Some six years ago there was much talk in this country about superheated steam. Then the plants for superheaters to be found might readily be counted on one's fingers. What is the situation today? There are plants aggregating close to one million boiler horse power capacity, fitted with superheaters of various types and practically all working successfully and many of them made up of orders which have been repeated two, three or four times.

"There is scarcely any industry which has not been invaded by the superheater—soap making, sugar refining, leather working, fertilizer factories, varnish making, core drying, asphalt rendering, ice making, timber preserving, copper refining, carpet making and oil refining are but a few of the great variety of industries which are making use of superheated steam, while still more prominent are the numerous steam power stations where electricity is generated, and water works pumping stations for municipalities.

"While superheated steam is largely used in the arts as a means for carrying a high temperature, its greatest field is to improve the operation and increase the efficiency of the various types of steam engines. This field has furnished the incentive for manufacturers to reach the present high state of efficiency.

"We find it quite impossible to give any cast-iron rules about the type of superheater to be chosen. Considerations of economical operation and frequently those of arrangement result in the choice of the type of superheater as combined with the boiler in most instances, and although the construction of a superheater differs materially from a boiler, as one unit they work very well together, sharing the heat from one furnace.

"The superheater is designed and adjusted to give certain temperatures under normal conditions, and when the conditions are variable, provision is made for counteracting the variations.

"The Separately Fired Superheater, on the other hand, has the advantage of great flexibility, and while possibly not so economical in fuel consumption, it is often preferred because of existing conditions peculiar to the locality.

"The amount of superheat to advise is a question which is subject to almost endless discussion. If we might be allowed to form a conclusion from the general tendency in installing plants we should say that the subject was rapidly resolving itself into two rather unequal groups:

"In the larger group a temperature of 500 degrees Fahr. is called for and it has been found in practice that most any type of engine, including those with Corliss valve gear, will readily stand this temperature without any ill-effects whatever. These would represent a superheat of 170 degrees, at 90 pounds pressure, or 130 degrees at 160 pounds pressure.

"The other group might be said to include those cases where 600 degrees Fahr. is called for, and under such conditions the motive power will be either a steam turbine, which when properly designed will not be affected by such temperature, or of a steam engine of the poppet valve type, which has been brought to such a high state of efficiency in Europe, but which has never gotten much of a footing in this country, which no doubt is because of their higher cost.

"It is a singular fact that the relative standing of the Corliss and the poppet valve engine in this country is completely reversed in Europe. I am inclined to think that the general use of superheated steam has something to do with this.

"During the past summer, while talking with several of the best engine builders in Europe, I was told that they never think of building a high-class plant without having superheated steam a feature, because of the better economy which they can get and because of the better working of their engines. They like to carry a temperature of about 600 degrees Fahr. and they like to use a poppet valve engine because it works so well with steam at this temperature.

"Experience with the popular Corliss valve gear in this country seems to prove that the temperature of 500 degrees is all that we ought to count on getting at the engine and at this temperature there will be no difficulties in the operation or in lubrication.

"It is a mistake to suppose that it takes a very expensive or high grade of oil for engines using superheated steam, particularly at moderate temperature. A mineral oil of any reasonable, good grade is recommended.

"The question of packing for the piston rod stuffing box when using superheated steam is also very simple of solution. Several good makes of packing have been used with success in different plants. Metallic packing is the best, of course. The writer has found Duval metallic packing very satisfactory for superheated steam. It also has the advantage of going into the stuffing box, which is designed for soft packing.

"These questions of lubrication, packing and whether the engine will stand the superheat are always raised by the engineer in actual charge of the machinery whenever the question of installing superheaters is brought up, and any data which bears on the subject is eagerly sought by those interested in superheated steam.

"We feel quite safe in making the statement that cases of trouble which are caused by superheat are of very rare occur-

rence and investigation of nearly every case will show that the real difficulty arises from other causes and should in justice never have been linked with the mention of superheat.

"When an engine has been in use for some time on saturated steam and superheat is then introduced in the proper amount for the class of engine and with due moderation, and perhaps gradually, we think it is safe to assume that there need be no fear of experiencing any difficulty. Numerous instances could be cited of almost every class of engine which has been so treated.

"If, however, a new engine is started up for the first time with superheated steam and anything goes amiss, it must be admitted that it is a great temptation to make a scapegoat of the superheater.

"An instance which came to the writer's attention during recent years was that of a large compound Corliss engine which was put in operation with steam at about 585 degrees temperature. It was soon noticed that the high-pressure cylinder was cutting and the fault was attributed to the high superheat. The temperature was then dropped 50 degrees but the cutting still continued. The temperature was further reduced until finally there was no superheat whatever. Still the difficulty existed and examination proved that the trouble all the time had been with the cylinder, which was soft iron, and the only way that the engine could be operated was by making composition metal piston rings.

"The form of construction which the writer has used most extensively consists of a row of cold drawn seamless tubes with the ends expanded into steel headers and the surface of the tube, which is exposed to the fire being covered with a series of cast-iron rings with tapering edges, so designed as to form a deeply corrugated external surface, the object being to protect the tube from the direct action of the fire gases and present a large surface for the absorption of heat from the destructive gases.

"Cast-iron resists the action of the hot gases better than any other metal and superheater tubes protected in this way are very durable.

"In order to get the maximum efficiency of heating surface, the interior of these tubes is fitted with smaller tubes closed at the ends, leaving an annular space between the two tubes through which the steam passes in a thin layer while receiving its superheat.

"Holes at the ends of the tubes are closed by plugs which are drawn down to an inside seat and are easily removed by taking off a nut.

"The resisting qualities of this form of construction are well illustrated in a certain plant which has been in successful operation for some time, carrying a temperature of 950 degrees Fahr.

"As in everything else there are good superheaters and bad superheaters, and in just such proportion as good superheaters are worth having, bad superheaters are worse than useless. Reliability is one of the qualities which makes superheat pay.

"The principles of superheat designing differ materially from those of the boiler. Superheaters should be simple, accessible, easily cleaned, occupy space so far as possible which cannot be utilized for other purposes, and must have a certain amount of elasticity so that the temperature can be adjusted if desired.

"When combined with the boiler, care should be taken not to impede the draft. Parts should be very strong and easily duplicated. It is a good feature to have a mass of metal in the superheater proper which makes an accumulation of heat and serves as a dampner between the fluctuations of the temperature of the fire gases and the steam being superheated.

"There have been a great many comparative tests of engines with and without superheated steam and the lack of uniformity in the results is doubtless due to the difficulty of reproducing absolutely identical conditions on two tests, but it is an interesting fact that although the degree may be different, the tests all show a saving of fuel in the use of superheated steam.

"As has frequently been stated in public, the greatest percentage of economy is to be found on what is known as the lowest or most simple types of engines which are not fitted with such refinements as are found on the more expensive types, but if we are to be guided by our European brothers, who have been the forerunners in the art of superheating, we must take the ground that superheated steam can be used even with the triple expansion engine, steam jacketed, to advantage.

"A prominent builder of engines in Europe publishes in his catalogue guarantee of steam consumption with superheated steam as follows:

	Lbs. per indicated horse power.
Triple expansion engine	8¾
Triple expansion compound engine	10
Single cylinder non-condensing	15½
Single cylinder condensing	13

"We Americans obtained our first notions about superheaters from abroad, but, as in many other things, our greater field has brought forth original ideas until now we stand right in the front rank in developing this important feature of steam plants and our next step should be to take the lead in steam engine economy as well."

Mr. Foster supplemented his paper with a few remarks relative to the applicability of superheated steam in locomotives and marine engines, and referred to the researches of Benjamin Isherhood, formerly engineer-in-chief of our navy with superheated steam, and his prophecy of some years ago that its use would rapidly extend as knowledge of it became known. Mr. Foster concluded by saying that as already within the past five years 1,000,000 horse power of superheaters have been installed, he considers this type of apparatus to be a success.

A 150 horse power boiler at the Hazard Rope Works in Wilkes-Barre, Pa., exploded on September 17th, causing the destruction of the boiler house and part of a large building adjoining. Pieces of the wrecked boiler were carried several blocks and four men walking on different streets were struck by the flying iron, but none were seriously hurt. Three dwelling houses near the works were damaged to some extent but all the occupants escaped uninjured. The engineer and employees do not know what caused the explosion.

Electric power from Niagara is now moving the street cars of Syracuse, N. Y., which is more than 150 miles away. It will be some time before all the cars in Syracuse will be run by hydraulic power but when that is done, all the local power plants will be shut down, to be used only in cases of emergency.

AUTOMATIC ALTERNATING-CURRENT REGULATOR

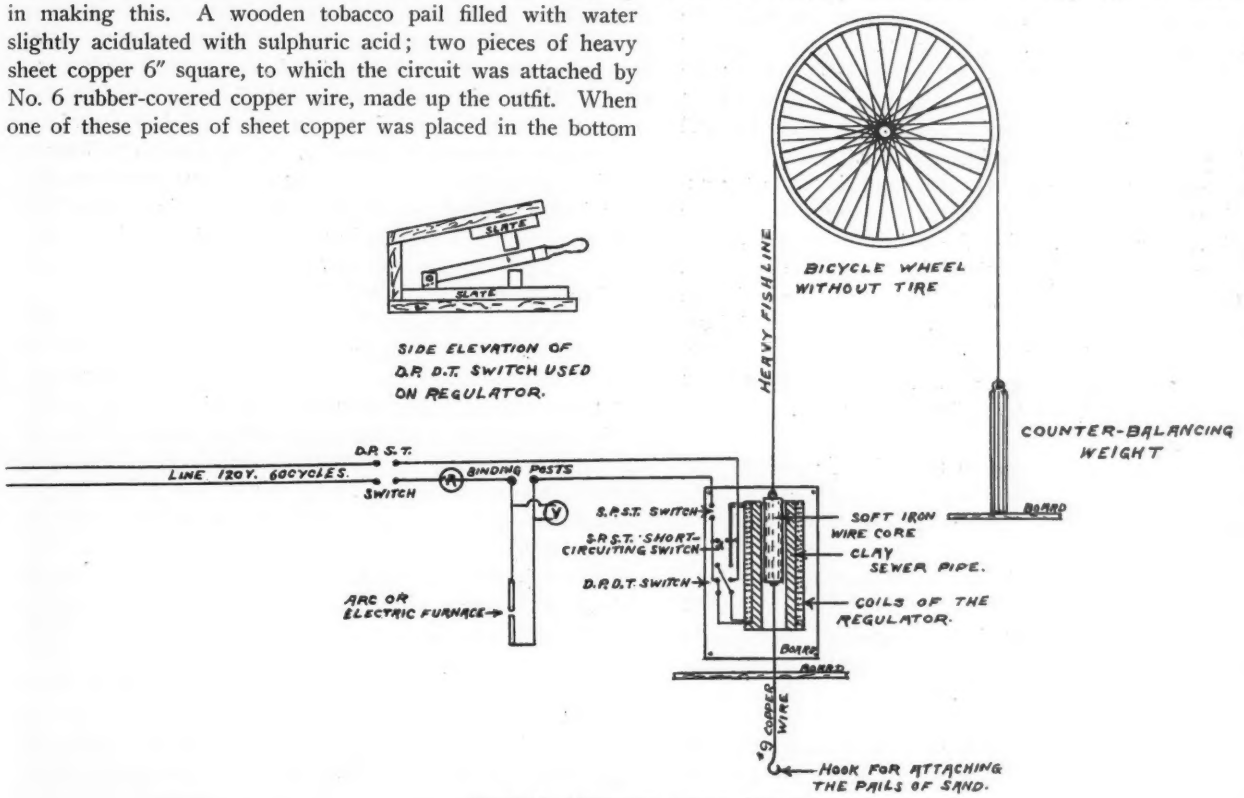
Interesting Account of the Construction and Operation of a Constant-Current Regulator

By F. W. Merrill, M. E.

Two years ago, while living in Chicago, Mr. James J. Doyle and myself undertook to perform some experiments with the electric furnace. We rented a small building, and had a 120 volt, 60 cycle alternating-current service installed. The size of our transformer permitted the steady use of 6 kilowatts, but for short intervals we were able to take out twice that amount.

The nature of our work was such that we needed a rheostat, or controller of some kind that would be capable of rapid and delicate adjustment. The first thought that came to our minds was to use a water rheostat. We found little difficulty in making this. A wooden tobacco pail filled with water slightly acidulated with sulphuric acid; two pieces of heavy sheet copper 6" square, to which the circuit was attached by No. 6 rubber-covered copper wire, made up the outfit. When one of these pieces of sheet copper was placed in the bottom

Referring to the diagram, it is seen that the regulator consists primarily of a coil of wire wound on a clay sewer pipe, and of a soft iron core which can be easily moved back and forth inside the pipe. The coil is made up of about six hundred turns of No. 9 single cotton-covered copper wire wound on in such a way that a multiple connection can easily be obtained giving three hundred double turns—thus greatly decreasing the impedence of the coil, and increasing its current capacity. The sewer pipe is a common red glazed tile about 18" long and 2½" inside diameter. The coil and pipe are mounted vertically on a board 2' 6" long, and 12" wide. The



Automatic Alternating Current Regulator

of the pail, and the other was slowly lowered down through the water, we obtained fine control of our current. But we soon gave up the apparatus because it was so terribly wasteful of power. One afternoon, when we had to run the furnace steadily for about five hours, using a current of fifty amperes, there was a drop of nearly eighty volts across the water rheostat and several pails of water were boiled away. This was too great an expense to be tolerated, so we immediately set to work to construct an apparatus that would absorb less power, and require less attention. After working several weeks, we evolved a controller that was very economical, and one that was far more delicate and self-regulating than we had ever hoped to obtain. It worked splendidly for two months; at the end of that time our experiments were completed.

ends of the wires are brought out and attached to the D. P. D. T. quick-acting switch, as shown, and there are also mounted upon the board two S. P. S. T. switches, one to make and break the circuit, and the other to short-circuit the coil in the event of a high resistance in the furnace. It may be seen from the diagram that when the D. P. D. T. switch is down on the lower contacts, the coils are in series, and when it is thrown to the upper position the coils are in multiple. The core consists of a bundle of annealed iron wires, No. 16 B. and S. G. A No. 9 copper wire was pushed through the central axis of this core, and bent into a ring above the core, and into a knot-like loop just below, so that it was firmly held in place in the bundle of iron wires. The copper wire terminates at the lower end, about two feet below the core,

in a hook. The bicycle wheel turns on its ball bearings, and is firmly mounted a few feet above the regulator board, as shown. The counterbalancing weight is just a trifle heavier than the bundle of iron wires, so that when the current is shut off the iron core will always be pulled to the top of the coil, as shown in the figure, and the counter-weight will rest on the shelf-like board fastened to the wall for that purpose.

The theory involved in this type of controller is simple. When the current is turned on, the magnetic flux immediately pulls the iron core down to the middle of the coil. If a weight is then hung on the hook at the lower end of the copper wire, the iron core will be pulled still farther down, the magnetic resistance (reactance) of the coil will be decreased and a greater current will flow. This greater current will produce a greater flux which will in turn pull up on the core enough harder to support the weight. If now there be an increase in the external resistance, tending to decrease the current, the flux will be momentarily diminished, and the weight will pull the core down a bit farther until the current has again regained its original strength. It is easily seen that a greater range of perfect regulation may be obtained by making the core considerably shorter than the coil, but there is a limit to this, too, and if I was to design another regulator I would work the problem out with considerable care.

With no weight on the hook and a short circuit in the external circuit, the coils of the regulator being in series, the current is seven amperes. With the coils in multiple the current under these same conditions is twenty-five amperes. When the iron core is removed and the full voltage is thrown on the open series coil the current reaches a value of forty amperes. We never dared to try this on the multiple connection, but I presume that the current would have been about one hundred and forty or possiblby one hundred and sixty amperes.

This simply serves to illustrate the principle that the reactance (6.28 N. L.) varies directly as the square of the number of turns, for "L", the coefficient of self-induction, varies directly as the square of the number of turns, or ($L = \frac{N^2}{R}$ where "R" is the reluctance of the magnetic circuit). The introduction of the iron core greatly increases the reactance, because it decreases the factor R, reluctance, and hence increases the valve of L.

The first thing that we did, after setting up the apparatus, was to connect the coil on short circuit with the ammeter in series. Then we hung a small tin pail on the hook and poured in sand until the ammeter had risen from seven to ten amperes. Then we marked this pail "ten amperes series", and put it aside. We graduated several more pails in the same way, up to about thirty amperes, then we changed to the multiple connection and began over again. In this case the pull exerted by the flux was tremendous, and we had to put a twelve pound weight on the hook to obtain a constant current of sixty amperes. For currents above this, which we only required for a few seconds, we simply pulled down on the hook and watched the ammeter. We took out one hundred and twenty amperes this way once through a sixty-five ampere fuse for a minute and a half before the fuse blew out. Of course, after we had been running sixty amperes for several hours, the coil used to get pretty hot, but we never burned the insulation.

And now just a word as to the behavior of the coil under conditions of practical operation. When we wanted to run a fifteen ampere arc, we usually touched the carbons together, first with no weight on the hook, and then, as soon as the current was started, we would hang on the series fifteen ampere weight. As the arc burned and the distance between the carbons increased, the weight would gradually drop lower and lower, the counterweight rising, and the current remaining constant. If the arc became broken, down would come the weight until the core struck the shelf-like board placed just under the regulator. If, at this stage, the carbons were again touched together, there would be a rush of large current, jerking the core violently up into the coil, and then for perhaps a minute the inertia of the system would keep the weights pumping up and down. This, of course, caused a variation in the current strength and was the only objection that we found to the regulator—it was not sufficiently dead beat—but this could be overcome by substituting for the bicycle wheel a paddle wheel working in a trough of oil or water. Then the controller would be ideal; but it was near enough so to fully satisfy our demands. If we wanted to work with twelve amperes, say, we simply hung on the weight and paid no further attention to the regulator. Open circuits and short circuits gave no trouble, except that one of us sometimes put a hand on the bicycle wheel to steady the moving part of the system, when it got to pumping, but we seldom had difficulty with this unless we deliberately made a short circuit when the weight was clear down, as before mentioned.

One of the most interesting and important parts of the regulator is the quick change D. P. D. T. switch mounted on the regulator board. It has been found by actual experiment that the current passing through an electric arc may be cut off for one-tenth of a second, only, without extinguishing the arc. It was necessary for us to be able to change from series to multiple connection while the current was on, so we thought out the arrangement of the switch shown, in side elevation, in the figure.

All that we did was to take an ordinary D. P. D. T. switch and saw off the part of the slate base containing the multiple contact, and mount it close above the blades of the switch. It was then only necessary to move the switch through a quarter of an inch to effect the change, and we were easily able to do this inside of one-tenth of a second.

It will also be interesting to know why we used a clay sewer pipe. That was the result of a lesson that we learned by experience. We first wound our coils on a brass tube about three inches in diameter. When we closed the switch there was almost a short circuit, and the terrible rush of current nearly ruined our ammeter. The coil seemed to have no reactance at all. Then we thought of what we had done. We had unconsciously made a transformer—the brass tube being a short circuited secondary of one turn. We attempted to remedy the matter by milling a slot the entire length of the tube, and putting in a strip of rubber. This helped very much, but the eddy currents in the tube were still so great that a few minutes running developed heat enough to burn the insulation on the coils. Then it very naturally occurred to us that a baked clay sewer pipe would be the ideal thing to use, because it was a non-conductor of electricity—and hence there would be no eddy currents; and it was an insulator of heat,

and would tend to keep the high temperature of the iron core —due to hysteresis—confined to the inside of the pipe away from the coils. This proved to be the case, and I feel sure that the apparatus as it was finally developed, and as it has here been shown and described, while possibly crude and home-made in appearance, is correct in principle, and only needs to have the various parts properly designed in relation to one another, and to have the paddle wheel arrangement—or something just as good—added to it, to bring the regulator to a finished state.

Simple Rules for Draftsmen.

To the mechanic, a drawing is more simple than any amount of verbal explanation. Ideas are expressed to him by a diagram as readily as melodies and harmonies are suggested to the musician by notes on the staff. The mechanical drawing gives all that it is desired to give—form, size, material and quality, if essential—but it is destitute of perspective, light, shadow and color, as a rule, and therefore some conventional method of conveying ideas is essential. Standards for drawings have not been adopted as yet, though there are a great many rules which are generally recognized.

Eugene Ransom, in a recent paper read before the Ohio Society of Electrical, Mechanical and Steam Engineers, presents a few simple and well-established rules for use in drafting rooms, which, if followed, would do away with the friction which so often occurs between the drafting department and the men who finally use the drawings. These rules are more or less familiar, but in many cases they are not adhered to. The rules which follow were taken from Mr. Ransom's paper:

1. Use the fewest possible lines accurately to represent the object.

2. Make these lines smooth and black and heavy enough to show white in a blue print.

3. Make views enough to show the object completely.

4. Where a number of parts are shown on one sheet, endeavor to group them in such a manner as to show their relations one to another. Much time will be gained in finishing, if the workman knows how the parts assemble.

5. Do not obscure a drawing by a lot of notes. Literature looks cheap on a drawing. The drawing should tell its own story without remarks, and the workman has a right to expect it. Besides, notes are a prolific source of error, as they tend to confuse or escape notice entirely.

6. Heavy lines should be used on the dark side of the object, and the light is always supposed to come from the upper left-hand corner at an angle of 45 degrees. This takes a trifle more time in the drafting room, but pays in the hands of the workman on account of greater clearness, especially when the part is complex.

7. Dimension lines should be heavy enough to be seen and their terminals clearly and strongly marked.

8. Enough figures should be on a drawing to give the dimensions completely and no more; more than enough tends to confusion, especially on a small drawing.

9. In giving the dimensions for a shaft, for instance, don't forget to give total length as well as the length of all parts. Someone has to cut it off.

10. Figures and letters should be large enough to be seen without the use of a magnifier and should be strong, perfectly formed and black. The man who works to your drawings may be wearing glasses.

11. Dimensions should be left off the object as much as possible, when they tend to confusion, and near enough to be seen with the object to which they refer.

12. Each sheet of the drawings should have an appropriate title, and each piece an appropriate name, with the number required for one complete machine, and where no section shows the material, that should also be indicated.

Pumping Engine Records.

The large pumping engines installed in various parts of the country are well known to exemplify some of the best attainments in stea mengine economy which have ever been reached.

The advance made in the design of pumping engines during the past few years is strikingly indicated in the following records which represent the maximum duty in foot pounds per 1,000 pounds of steam for each year. They are as follows:

1893	154,048,700	foot	pounds.
1894	157,843,000	"	"
1898	167,800,000	"	"
1900	165,532,800	"	"
1900	178,497,000	"	"
1900	179,454,255	"	"
1906	181,068,605	"	"

The record for 1893 was made at the North Point Pumping Station, Milwaukee. The record for 1900 which reached 178,497,000 foot pounds, was made on May 1st and 2d by the 30-million gallon pump installed at the Chestnut Hill High-Service Station of the Metropolitan Water Works of Boston. The other two records for 1900 were made on February 26th and 27th at the Baden High-Service Station, St. Louis. The 1906 record which has distanced all previous figures was made in test on February 20th and 21st at the High-Service Pumping Station at Bissels Point, St. Louis, on a 20-million gallon pumping engine.

How to Tell if a Grease or Oil Contains Graphite.

Of late we have frequently been asked if there is any method of telling whether a grease or oil contains graphite.

We know of no method more simple or more thorough than to take a small quantity of any such grease or oil and put it on white blotting paper. The blotting paper will absorb the oil or grease while the graphite will remain on the outside.

To hasten the matter the oil or grease may be rubbed into the blotting paper with the finger.

Another way is to use a piece of filtering paper and if necessary warm the oil or grease. The paper will filter out the oil or grease and leave behind the graphite.

By this method it would be determined just how much graphite the oil or grease contains and it would also be determined whether the graphite is the flake or amorphous graphite, and often it would be determined if the oil or grease contains impure or gritty graphite.—*Graphite.*

To obtain the amount of air in cubic feet per minute that can be produced by different size air cylinders, find the area of the cylinder and multiply that by the stroke; then multiply the result by 2 if it is a straight line compressor; by 4 if a duplex compressor; or by 2 if a compound duplex compressor. Divide this by 1,728 which will give the cubic feet of the stroke and then multiply by the number of strokes per minute.

The
Practical Engineer

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Denatured Alcohol.

The use of alcohol in the arts and for internal combustion engines has long been held in check by the very excessive tax which all civilized communities have put upon it. It has always been a source of large revenue to all countries, so that it seemed almost impossible that it would ever become available for engineering uses, owing to its excessive cost.

The last session of Congress, however, devised a scheme whereby it could be used without tax for certain purposes, providing that it was denaturized. This means that certain substances shall be added to it so that it will be deadly poison to those who attempt to drink it, but at the same time it will not affect its use for internal combustion engines. Just what substances will be used for denaturizing it it has not yet been determined, but when the proper authorities have determined this, it will be denaturized under government inspection. Wood alcohol and pyridine have been suggested for denaturizing material, but the substance as yet has not been decided upon.

The production of alcohol is so simple and its supply so unlimited, that it gives to the power user a prospective fuel which is practically inexhaustible. It can be made by the simple fermentation of sugar and starches and so long as plant life is not extinct, these substances will be available. At the present time, it is made principally from corn and potatoes but many other substances can be used.

Alcohol is particularly desirable as a fuel because it does not contain any tarry matter and burns without odor. It is less inflammable and less volatile than gasoline or kerosene and for those reasons would incur less fire risks in the handling. It is also generally stated that the efficiency of an alcohol engine is twice that which is obtainable in the best steam engine. Results of tests come from Germany, where alcohol engines have been used pretty widely, which show that an efficiency of 33 per cent. was obtainable from an alcohol engine, while 19 per cent. was the highest obtainable from a gasoline engine, and 15 per cent. the highest from a steam engine. The gain in economy is said to be mainly due to the greater compression under which alcohol can be worked, which means a greater expansive action and a higher thermal efficiency.

The practical reason why this subject of alcohol combustion is creating considerable attention, other than its economical factor, is due to the fact that the production of gasoline is restricted naturally and artificially. The enormous increase in the number of gasoline engines during the past half-dozen years has caused considerable anxiety as to how long the somewhat limited supply of this substance will last. Besides this, the production of gasoline is in the hands of the largest trust in existence, and by a mere change in price, which the trust commands at will, the fate of the gasoline engine would be held in the balance. Unless some very unforeseen condition arises, this would not be true of alcohol, as it can be made anywhere and everywhere.

Wood alcohol, which is not taxed as is the ethyl or grain alcohol referred to, has never been used for combustion engines owing to the fact that it is more or less impure, containing as it usually does, acetic acid, acetone and considerable tarry matter. It is obtained by heating wood in a still without the presence of air and is more expensive to manufacture than the grain alcohol.

As regards the use of alcohol in gasoline or kerosene engines,

there are many different opinions. Some engineers claim that it will be only sufficient to change the carbureter and the degree of compression, while other engineers claim that a distinct design of alcohol engine will be necessary.

Whatever success the alcohol engine will attain, it is assured that it must go through its state of development like any other engine. Many experimenters are now working along that line, so that there can be no doubt in the future that a successful and economic thermal engine will be obtained using alcohol.

It seems to be the purpose of the government, at the present time, to restrict the manufacture of denatured alcohol to only large alcohol plants, so that the government can be sure of the denaturizing process, but it seems to us that the greatest future of the alcohol engine would be to equip with it an alcohol still and use the resultant alcohol as it is manufactured. It would thus possess all the advantages of the suction gas producer plant with the additional advantage that the gas would be pure and the products for making the gas inexhaustible.

The day may not be far distant when large power houses may be erected in the centre of a corn field, there being a government inspector on the ground to see that the alcohol is thoroughly denatured or used for its proper purpose, and the power will be transmitted to its point of application.

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The Poppet Valve and Superheated Steam.

It is well known that superheated steam is used in many of the largest power plants in Europe, and in most of these plants where superheated steam is used, the poppet valve engine is the prevailing type of prime mover.

In this country, a great deal of doubt is usually expressed as to the availability of superheated steam in a well-constructed plant, owing to the doubtful gain in economy and the increased trouble of lubrication, and with packings. There seems to be no doubt that with a poorly-constructed single-cylinder engine, a moderate degree of superheat is beneficial, but the best engine designers in this country will not admit that superheated steam will give more economical results when used with compound or triple-expansion engines.

The fact that superheat and poppet valves have followed so closely together in European practice has led many persons to believe that this type of engine is necessary for the successful utilization of superheated steam. The particular advantage which the poppet valve possesses is due to the fact that it has no sliding friction on its valve seat. The slide valve and Corliss valve each must slide upon its seat and with the dry heat which is characteristic of superheated steam, this means more or less difficulty of lubrication.

The strongest advocates of the superheater treat the subject of lubrication with superheated steam very lightly, but it is safe to say that a large amount of trouble must necessarily be encountered if the proper oil is not used in the cylinder and valve chests. In fact, in the very place where superheat seems the most beneficial,—in the steam turbine,—there has been trouble encountered due to the intensely dry gas in which the turbine blades revolve and many plants, which were erected for the purpose of using superheated steam, are now running on the more moist saturated steam. In fact, one turbine plant which was equipped with superheaters, after encountering trouble with the warping of the turbine blades, stripped the steam pipes of their covering so that a lesser degree of superheat could be obtained until the superheaters could be removed.

The failure of superheated steam in many plants, however, should not necessarily condemn its use in general. It only proves the value of engineering experience and there is no doubt that in particular cases, it is giving apparent good economy and satisfaction.

If the poppet valve engine will assuredly give good economical results when using superheated steam, it is to be hoped that more of these types of engines will find their use in this country so that the issue of the superheated may be tried to a more definite conclusion.

—o—

Technical Spelling.

For many years there has been more or less of a rebellion among writers against the manner in which many words are spelled and while from time to time small dents have been made on our language by men who expected that their puny efforts would cause the English language to be reformed, it remained for President Roosevelt to stir up the greatest agitation about it.

While everybody agrees that the spelling of many words in our language can be improved upon, the question seems to be not where shall the reformers begin, but where shall they stop? If gauge is spelled gage and catalogue is spelled catalog, without the final ue, then according to these phonetic advocates, sugar should be spelled shugar, sulphur as sulfur, power should be spelled as powr and so on, indefinitely.

If the change of spelling were left to the authors and writers in this country, there would be no doubt that they all would be overwhelmingly in favor of reform of some sort, but their wishes should not affect the 180,000,000 people who use the English language. The fact is this reform will affect only a very small number of people and it is very probable that even at the beginning of the twenty-second century, millions of people will still be spelling as their great-grandfathers did before them.

The trouble is that the general public does not even approve of the medicine which the word doctors are trying to give them and so far as engineers are concerned, they are so busy trying to understand the principles of their profession, that to change the spelling of words with which they are familiar would impose an unnecessary hardship on them.

So far as our readers are concerned, there are probably thousands who have never even heard of the change of spelling which is advocated by the spelling reformers and since this paper has been trying to give the reader what he wants, and not what we think he ought to have, we shall try to please him in the spelling of technical and other words, as we are trying to do in all the other departments of the paper.

—o—

Salt water boils at a higher temperature than fresh boiler owing to its greater density and because the boiling point is increased by any substance that enters into combination with it. The density of water decreases as the temperature increases, because heat destroys cohesion and expands the particles, causing them to occupy greater space.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Answers to F. L.'s Questions.

EDITOR THE PRACTICAL ENGINEER:

The following are the answers to some of the questions asked by F. L., of Chicago, Ill., on page 26 of the August issue:

1. This question cannot be answered without knowing the amount of fuel burned and its heating value, as well as the temperature of the feed water supplied to the boiler.

2. While it would be easy to make the diagrams and say nothing as to how the work is done, this would be of little value to the readers of the paper. To properly explain the mathematical construction of the diagrams called for by this question would require the space of a lengthy article which is too long to take up in this letter.

3. I should make the grate 6 x 8 feet, so that the area would be 48 square feet, which is practically $^1/_3$ square foot per horse power of the boiler.

4. The size of safety valve for a tubular boiler may be said to depend on the number of pounds of coal burned per square foot of grate surface per hour, the total area of the grate surface, and the steam pressure carried. For a pressure of 150 pounds and a coal consumption of 15 pounds per hour, with a total grate surface of 30 square feet, the safety valve should be 2½ inches in diameter.

5. The maximum lift of a valve is about one-fortieth of its disc diameter.

6. Probably the inspector would have something to say about this setting of the safety valve or rather about the pressure to be carried. It all depends on the style and condition of the boiler and the length of time it has been in use, with the care it has had during that time. Ordinarily the valve is set to blow at about 5 pounds above the working pressure.

7. More uniform air distribution (owing to more symmetrical disposition of the metal and the openings) and hence better and more uniform combustion. More perfect control of the fire in regard to breaking up clinker, or rather keeping them from forming and greater ease in operation.

8. In the Corliss valve gear, each of the four valves can be set independently and hence more nearly correct, so that the steam distribution is better than with other valve motions and the economy in fuel very marked. The motion is also simple and is such that cutoff is quick and sharp. This point is one of the great advantages of the motion.

9. Bituminous coal smokes more than anthracite because it contains more volatile matter than the harder coal. This volatile matter absorbs heat from the fire and requires a high temperature (about 1,300 degrees) for ignition. Owing to the fact that there are at least three absorptions of heat in burning this coal, namely: to liberate the volatile matter, to supply the energy taken up by the volatile gases in expanding, and to ignite the gas. Unless special provision is made to store up heat in brick linings or otherwise, the temperature of the boiler furnace is reduced below that required for igniting the gases, so that they pass off in the form of dense black smoke.

10. Cylinder oil is composed of mineral matter, while machine oils are made from animal and vegetable fats.

11. Air pockets and leaks, too small pipes improperly insulated on the transmission lines, and poor arrangement of piping with regard to the duty to be performed and the strains of expansion and contraction are some of the things that will cripple a heating plant.

Chicago, Ill. E. S. H.

Will a Dynamo Generate in a Vacuum?

EDITOR THE PRACTICAL ENGINEER:

In answer to the question: "Will a dynamo generate in a vacuum?" I would say yes, as a vacuum does not offer a much greater reluctance than does the atmosphere. It therefore looks pretty reasonable that a dynamo placed in a vacuum will generate; but how long? Here we come to the question of heat, there being no air to carry off the heat that is generated by the machine. We know that in a vacuum the insulation will not burn, but how about the bearing? I think that is where you would find the greatest difficulty.

The bearing might be covered with a water chamber, the same as is done with gas engines, and let the rest of the machine get as hot as it wanted to—provided there was a perfect vacuum.

By having the generator in a vacuum, the resistance of the air to the rotation of the armature would be overcome, but I think that this advantage would be more than overcome by the other disadvantages and trouble and expense of maintaining the vacuum and cooling system.

Coeur d'Alene, Idaho. P. M. E.

Examination Questions Should Show Ability to Reason.

EDITOR THE PRACTICAL ENGINEER:

I have been much interested in the debate over examination questions which has been going on in your paper and I would like to give my views on the subject.

It seems to me that the reason the license law was passed originally was for the purpose of protecting the public from boiler and fly-wheel explosions. When an engineer has passed an examination for third-class license he is practically proclaimed a safe man to have charge of an engine and boiler of a certain size, but as the principles upon which boilers and engines operate, as regards the safety to the public, are the same with large as small, I fail to see why that engineer isn't safe in a large plant.

However, the examiners have seen fit to carry the examination further than safety and require that a man should have ability to run any plant which he has a license to operate, in an economical and intelligent manner. In my opinion, therefore, an engineer of this kind should be capable of answering the questions as given by J. R., in the May issue.

An engineer, studying for a first-class license in Massachusetts, should get a good work on compound engines and study it thoroughly. He should also watch his engineering papers and when a new plant is described, if the engine is compound, for instance, he should take the data given and figure out all

the details, using different steam and receiver pressures. By comparing this with others, he will be surprised at the information gained. This is also true of all apparatus pertaining to a first-class plant.

It is useless for anyone to memorize a lot of rules that he does not understand. If one thoroughly grasps the subject, he will have very little trouble. The questions asked regarding compound engines, as mentioned by J. R., were probably given to find out what he knew about the subject. An examiner once said to me: "We don't expect a man to answer all our questions, or to know it all. We want him to show ability to reason."

Because an engineer is well versed in theory, it does not follow that he will be a success if he is not practical also. If he combines the two, he is by far the best engineer. How would an engineer determine the best steam and receiver pressure for the economical running of a compound engine if he could not answer any of the much-discussed questions about the 2000 horse power compound engine?

The writer has been through the mill himself and has had to get down and dig and is quite familiar with Room 3, State House, Boston, as he has had to make a few visits there before making good.

N. Abington, Mass. R. D.

Wear in Locomotive Cylinder. Compressed Air for Injectors.

EDITOR THE PRACTICAL ENGINEER:

I have read with much interest the explanation of the wear in the locomotive cylinder, described by John Burns, on page 22 of the June issue, and think that his statement of the case is about right. In fact, from the position shown in his figure, the theory of the hammer action worked out by him is just the thing that would do the business. The crosshead in this position may be compared to the hand of a man holding the hammer, but when the crosshead has moved to the other end of the stroke we have the case of the man trying to drive a nail with the hammer handle stuck through a knot hole up to the ball of the hammer. I can work out no reason for the wear at the crank end of the cylinder so long as the guides have no unusual amount of play and the stuffing-box is properly set.

On the opposite page of the same issue, P. J. wants to know what would prevent compressed air from being used to feed the water into a boiler with an injector, instead of using steam? There are several reasons, some of them on account of the nature of the injector, and others on account of other considerations not directly affecting the matter of getting the water into the boiler. In the first place, the steam is condensed when it gets into the injector and this cannot be the case with air. In the second place, there are good reasons why air should be kept out of a boiler. It is known that the oxygen of the air aids any acids that may be present in the water to pit and corrode the boiler and even if no acids are present, the air and the water together cause oxides of iron or ordinary rust to be formed. Another objection to the use of compressed air would be the bad effect on the vacuum where the engine is run condensing.

Chicago, Ill. E. S. H.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Rules for Finding Mean Effective Pressure.

EDITOR THE PRACTICAL ENGINEER:

Some years ago, there was printed a very good rule for finding the mean effective pressure in an engine cylinder, which I would like to see printed again, if you have the rule. The rule, I think, read as follows: "Knowing the initial pressure and point of cut-off of an engine, find the mean effective pressure without having to refer to any engineering book or without using the rule for initial pressure multiplied by one plus the hyperbolic log. of the number of expansions, divided by the number of expansions."

I am sure the rule I refer to could be carried in a person's head and would be a very good thing for engineers going before examiners for their examinations. I think this rule would be a good thing for engineers and hope you will find space for it.

Fall River, Mass. M. H. H.

This question was referred to Mr. C. J. Mason, who has written the article: "How to Find the Mean Effective Pressure," found in another column of this issue, in answer to it. —[Ed.]

Setting Pump Valves.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly explain to me how to set the valves of my duplex pump?

Baltimore, Md. M. R. S.

Steam pump valves, in general, can be set as follows:

The steam chest cover should be first removed and the stuffing-boxes of the piston and valve rods slackened, so as to permit the rods to move freely through the packing. The rocker arms should then be brought to a vertical position. When the levers are plumb they occupy a position known as mid-stroke and were it not for the play necessary between the valves and the lock nut on the valve stem, the valves would occupy the corresponding position known as mid-travel.

Pump valves have no lap, so that when they are placed at mid-travel, the ends of the valves should just cover the steam ports, the edges of the valves and the outer edges of the steam ports being then in line.

After placing the rocker arms in a vertical position, measure the width of the steam port and set the valves squarely over the ports so that both steam ports on both sides of the pump will be closed. The space between the nut and the lugs on the back of the valve should be equal to one-half the width of the steam port; that is, if the valves were to be moved in

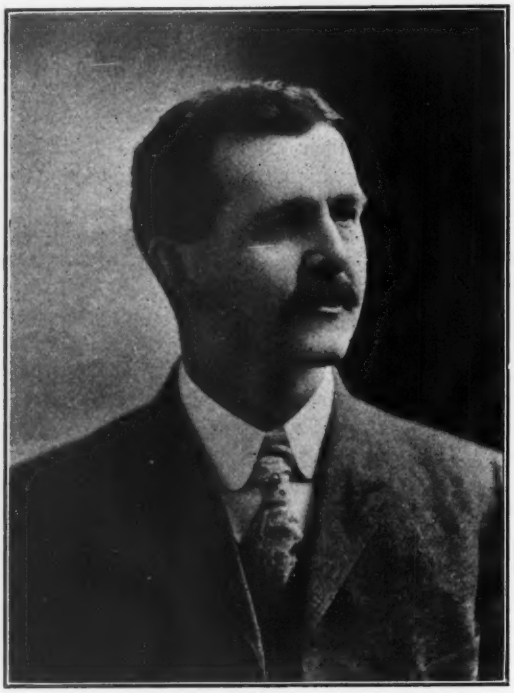
either direction, the steam ports would be equally open. As the valves will now be in a position to entirely prevent the admission of steam into the cylinders, it will be necessary to move at least one of them off the centre so as to open one of the ports. The steam chest cover may then be put on and the stuffing-box glands tightened, after which the pump will be ready to run.

Joseph H. McNeill Appointed Chief Inspector of Boilers in Massachusetts.

Governor Guild, of Massachusetts, has just appointed Joseph H. McNeill chief inspector of boilers and examiner of engineers, in charge of the issuing of engineers' licenses. McNeill's percentage in the civil service examination was higher than that of any of the other candidates for the office

More than ten years ago Mr. McNeill told the editor of THE PRACTICAL ENGINEER that it was his ambition to become the best engineer in the State of Massachusetts and that some day he hoped to be an inspector. He has made good.

He was born in Prince Edward Island and was educated in the public schools there and at the Prince of Wales college. He served five years as an apprentice in the machine shops of



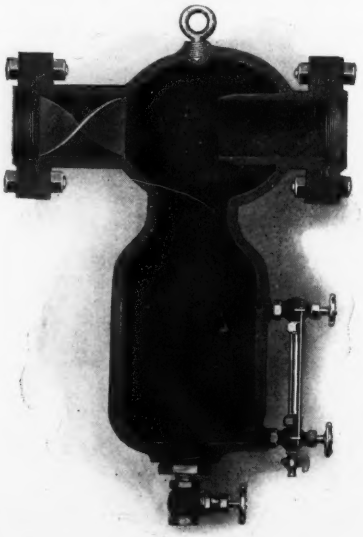
Joseph H. McNeill—Chief Boiler Inspector of Massachusetts

the Prince Edward Island railroad, and was one year in the master mechanic's office as timekeeper and draftsman. Later he was a journeyman in the iron works in San Francisco; at Denver, Col., and for the Manhattan Railway. He was a marine engineer for three years, two of which were in the ocean service.

He was stationary engineer and master mechanic for the Citizens' Water Company, of Denver, and for the Hood Rubber Company in Watertown. He has been State inspector and examiner of boilers eight years. He has a chief engineer's license for ocean steamers in the United States in the merchant marine and a first-class engineer's license from the British Board of Trade. He has had a first-class license in the State since 1895.

The Swartwout Horizontal Separator.

The accompanying illustrations represent the interior and exterior views of the "Swartwout" horizontal separator which possesses many features of merit and is constructed upon the practical and effective method of applying the principles of centrifugal force to the separating of the water from the steam.



The Swartwout Horizontal Separator

The construction consists of a helical worm in the entrance pipe of the separator. The steam from the boiler, which contains water in suspension, is made to strike this worm, causing the mixture of water and steam to rotate rapidly. The resultant centrifugal force drives the water to the periphery of the helical worm when it trickles to the bottom of the receiver and is allowed to escape out of the drip pipe provided for that purpose. The steam, freed from moisture, passes through the centre of the separator to the engine. As will be noted the steam has a continuous flow always in the same direction, so that there is a minimum amount of pressure loss within the apparatus.

The manufacturers of the "Swartwout" separator are the Ohio Blower Company, 43 Michigan Avenue, Cleveland, O., who will be pleased to allow engineers to make any test of efficiency of the degree of separation of the water in the steam passing through their separator. Any engineer desiring to test this separator is requested to write to the Ohio Blower Co. for their free trial proposition.

The Death of George W. Lord. Noted Chemist and Engineer. Pioneer of Boiler Chemistry.

The death of Geo. W. Lord, president of the Geo. W. Lord Co., occurred on September 13th. Mr. Lord had been in ill health for some time so that his death was not entirely unexpected. He was 73 years of age and for over 40 years was a leading authority on the treatment of boiler feed waters.

Mr. Lord began life as an engineer and while in this occupation he realized the need of some special treatment to pre-

vent scale formation within the interior of the boiler. Being also a chemist, he analized the boiler waters which he used and prescribed a treatment which he found most successful. This was in 1865 and he thus became the pioneer of boiler chemistry in this country.

From that time on, Mr. Lord's life was centred in his laboratories and he became a noted authority on boiler scale treatment. His investigations gave him an endless amount of data and he was consulted by many of the members of the most learned technical societies.

Mr. Lord leaves behind him the enormous and well established plant of the Geo. W. Lord Co., which he so conscientiously built up and his Company stands today as a monument to his memory.

The sincere sympathy of all who knew him goes out to his family and to those with whom he worked for so many years.

The Twenty-Fifth Annual Convention of the N. A. S. E.

The Twenty-fifth Annual Convention of the National Association of Steam Engineers was held in Philadelphia, from September 10th to September 15th, inclusive. In point of numbers, the convention was the most successful ever held and the character of the exhibition furnished by the National Supply Men's Association far surpassed in beauty and variety any exhibition ever given during the twenty-four years of the history of the N. A. S. E.

Twenty-four years may not seem to be a very long life of an organization when looked upon in retrospect, but it is safe to say that when the National Association of Steam Engineers was organized in New York in 1882, not one of the most far-seeing engineers would have predicted the success which this organization has now attained. Twenty-four years ago, the steam profession may almost be said to have been in its infancy, notwithstanding that for a half-century before the application of steam for doing work was pretty thoroughly understood.

The formation of the N. A. S. E., however, occurred at a time when those who were most familiar with the internal workings of a steam engine and those who were also acquainted with that then puzzling force of electricity, kept what they knew to themselves and threw around the subjects of the indicator and the electric light such a halo, that those who were not endowed with the especial eyes of a scientist could not hope to penetrate.

In contrast, on September 10, 1906, representatives of about 18,000 engineers met in Philadelphia, Pa., for the principal purpose of formulating plans whereby the knowledge, which is necessary for the better understanding of the science and practice of stationary engineering, could be better disseminated and so give the greatest number of engineers those things which would increase their storehouse of knowledge and make them more valuable men to themselves and to their employers.

And so it was that on September 10th to the 17th, the National Association of Steam Engineers celebrated the silver anniversary of its birth amid surroundings that were most pleasant and congenial. On Monday, as the delegates were arriving from various parts of the country, the portals of Philadelphia's hospitality were thrown open and the visiting delegates and friends were received at the various railroad stations and conducted to their hotels and the registration booth at Horticultural Hall, where the exhibits were held.

Group of Delegates and Visitors to the 25th Annual Convention at Philadelphia

On Monday evening, at Hotel Walton, which was used as the convention headquarters, a reception was given to the National Officers and visiting delegates. This reception was given in the ball-room and the many pretty and well-dressed ladies present almost outnumbered the men. Refreshments were served, while a large orchestra played many catchy dance tunes, some of which the delegates could not resist and they danced in and around the groups of persons who were renew-

ing old acquaintanceship.

The introductory exercises were opened at the Broad Street Theatre, the convention hall, at 10.30 A. M., on Tuesday morning. The first floor was filled with delegates while the first balcony was filled with visiting ladies and guests. Richard Pape, the chairman of the local committee, acted as presiding officer and after briefly welcoming the convention to Philadelphia, on behalf of the engineers of the city, the exercises was formally opened by Bishop Cyrus Foss, who delivered an appropriate prayer. Mayor John Weaver was next introduced and was warmly welcomed by the assembled delegates. He spoke of the appropriateness of the convention meeting in Philadelphia and said that he hoped every delegate would take the opportunity of visiting, at least, some of the soul-stirring reminders of the Revolution, so that each one would go home with a greater sense of appreciation for that liberty which was so dearly purchased by the forefathers of this country.

The Mayor then congratulated the N. A. S. E. upon having an organization which was devoted solely to education and he commended the organization upon their constitution which forbids the association to be used for the furtherance of strikes or for political or religious purposes. He then extended the freedom of the city to the visiting delegates and he paid a glowing tribute to the ladies when he said that the city would certainly be safe in the hands of those assembled since they were accompanied by so many beautiful ladies.

The response to Mayor Weaver was made by National President, Royal D. Tomlinson, who thanked the Mayor for his cordial welcome to the delegates. He spoke of his earliest impressions of Philadelphia, which he obtained while visiting the Centennial Exhibition in 1876. It was there where he saw the large Corliss engine, which at that time was the marvel of engineers, and as he walked around it and watched it for hours, he then and there made up his mind to try to master the intricacies of the steam engine, which accounts for his present vocation.

Group of the National Exhibitors' Association of the N. A. S. E.

Mr. Alba Johnson, of the Baldwin Locomotive Works, was next introduced and he extended a hearty welcome to all the delegates and visitors to visit the Baldwin Works. Mr. Johnson alluded to the magnitude of his Company, which turns out 2,500 finished locomotives each year and which employs 19,000 men, and said that without the stationary engineer the operation of his works would be impossible. Mr. Johnson spoke of the development of power generation and the transmission of power along various lines, such as electricity and internal combustion engines and said that regardless of what lines such developments might take, the stationary engineer would always remain a prime factor in the situation.

Vice-President Theodore N. Kelsey, of Lowell, Mass., responded to Mr. Johnson's address. He made the hit of the morning when he referred to Mayor Weaver as a great engineer because of the manner in which he fixed the political

machine of Philadelphia. He spoke of the identity of interests between the employer and the engineer and traced the growth of the stationary engineer during the past twenty-four years and made a plea for harmony among all stationary engineers.

Prof. H. W. Spangler, of the University of Pennsylvania, made a number of humorous remarks about stage-fright and the engineer as a public speaker. As the head of the department of engineering at the University, he extended an invitation to visit the University and inspect its engineering features and he described the progress made in engineering during the past 30 years at the University.

Mr. Charles H. Garlick responded to Prof. Spangler, and his remarks were particularly humorous, especially as to the kind of education each of the various delegates from different sections of the country possessed. The serious part of his talk pertained to what the Association had done for all the stationary engineers throughout the country.

The convention was then formally opened at 11.30 A. M., by President Tomlinson, who appointed the various committees necessary for the transaction of business. On the convening of the afternoon session, President Tomlinson read his annual report and the various officers read their annual reports.

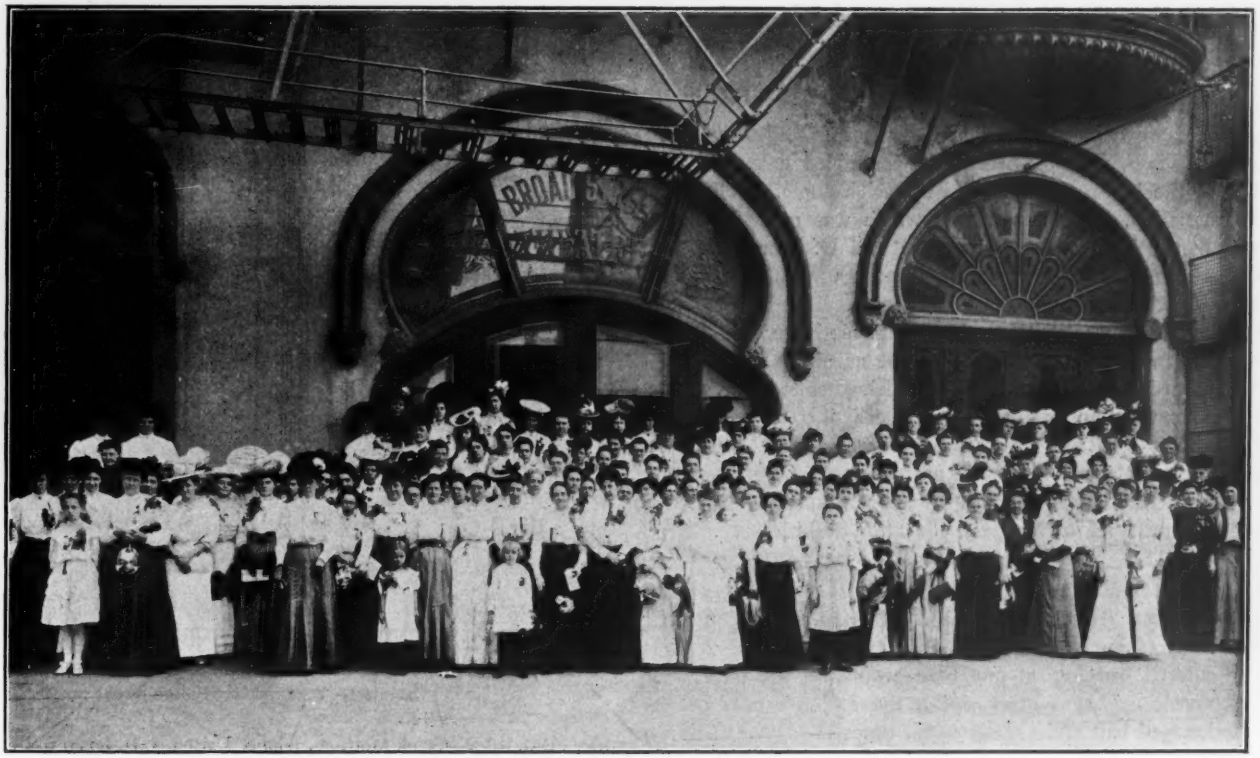
On Wednesday morning, the business of the convention was taken up by the reports of committees and other matters pertaining to the details of the Association. In the afternoon, all the delegates and visitors, accompanied by the ladies, embarked upon a specially chartered steamboat for a ride on the Delaware River. The course of the boat included a view of Cramp's shipyard, the New York Shipbuilding Co., League Island, Red Bank, Chester and the various shipping industries on the Delaware. The boat was a large three-decked excursion steamer and fun and jollity prevailed everywhere. On the lower deck at the front of the boat, all the well-known fun-makers of the Association had an opportunity to display their varied accomplishments. At the rear of the boat the entertainment committee provided a variety show, music and dancing. On the upper decks were scattered groups of delegates and their wives, who enjoyed the fresh air and scenery. Refreshments were provided in abundance.

Thursday morning was principally taken up by the discussion of the best place to hold the next convention. Niagara Falls; Kansas City; Canton, Ohio; Norfolk, Va.; Williamsport, Pa., and Jamestown, Va., each put its best foot forward, but the ballot on roll call resulted in the selection of Niagara Falls as the 1907 convention city.

Thursday afternoon was devoted principally to the reading of technical papers, which for the first time took their rightful place in the program of the convention. Capt. Crawford, U. S. N., read a paper on the duties of an engineer. The speaker spoke of the possibilities of the coal pile and showed the enormous losses which are constantly going on, in connection with which he said that it was the duty of every engineer to handle the coal pile as if it were his bank account, so that he could give account of every heat unit in the coal pile. Capt. Crawford then said that he considered it the duty of every engineer to be well educated and abreast of the times and that he should not rely too much upon experience as it generally creates an atmosphere of old foggyism.

Mr. E. H. Foster followed this with a paper, entitled: "Superheated Steam", which will be found in another column of this issue. A short discussion followed this paper.

In the evening, a theatre party was given to the delegates



Group of Lady Visitors at the N. A. S. E. Convention, Philadelphia

and guests at the Eleventh Street Opera House.

On Friday morning, the business session of the convention was resumed. The morning was principally taken up by a love feast following a technical paper read by Mr. John C. Quinn, on "Combustion", and the report of the committees on standardization of materials and on mileage. Various votes of thanks to the supply men, to the local committee and others were passed around. President Tomlinson was presented with a handsome watch chain and Mrs. Tomlinson was presented with a valuable set of cut glass. Past-President Chas. H. Garlick was awarded a past national president's jewel in recognition of his faithful services. Columbus Dill, one of the oldest members of the Association was presented with a diamond stud by his admirers. The prizes for the best educational work were awarded to Wisconsin No. 1, of Milwaukee; Illinois No. 17, of Moline, and Massachusetts No. 17, of Lowell.

Friday afternoon was devoted to election of officers and the storm centre hovered around the election of vice-president. The election resulted as follows: President, Theodore N. Kelsey, of Lowell, Mass.; Vice-President, Joseph F. Carney, of New York; Secretary, F. W. Raven, of Chicago; Treasurer, Samuel B. Forse, of Pittsburg; Conductor, Daniel J. Hussey, of New York; Doorkeeper, L. H. Fenn, of Atlanta, Ga.; Trustee, Alfred Johnson, of Chicago.

On Friday evening, the above officers were installed by Past-President C. F. Wilson, before the assembled delegates and ladies in the ball-room in Odd Fellows' Temple. Following the installation, there was a ball, which was opened with a grand march led by Mr. and Mrs. Royal D. Tomlinson. It was here that the gallantry of the delegates and the gracefulness and beauty of the ladies shown forth. It is said to have been the most successful function of its kind ever held. Refreshments were served throughout the evening.

On Saturday morning, most of the delegates took advantage of the excursion to Atlantic City, where they took a dip in the ocean, walked along the famous boardwalk and otherwise enjoyed themselves at this well-known resort. Saturday evening saw most of the delegates on their return home after a very pleasant week of business, education and pleasure.

The Ladies.

A N. A. S. E. cnvention without ladies would seem like fun in a desert. Everywhere throughout the convention week it was refreshing to see the well-dressed ladies with their multi-colored badges; at one time occupying the gallery of the convention; at another doing the social honors at the reception and ball and usually at all times they could be seen winding their way in and around the numerous exhibits in the exhibition. If they did not take as much interest in the exhibition as the men, they certainly did in the souvenirs which each exhibitor so kindly provided and it must have been a crusty old bachelor, indeed, who could have resisted the winsome smiles as they were asked for a fan, pocke-book or other desirable article which they were giving out.

The Ladies' Auxiliary, to which most of the ladies belonged, held their seventh annual meeting at Hotel Walton, on Wednesday morning. The session was called to order by Mrs. James S. Gillespie, of Philadelphia, after which the session was opened by prayer. Miss Mazie Jahn rendered a piano solo and Mr. Samuel Hibbs welcomed the ladies to the city. The response to the address of welcome was made by Mr. Herbert E. Stone, past-president of the N. A. S. E., and the musical program included vocal selections by Mrs. W. Glenn and Miss Edith Gallus. Mrs. Grace B. Goldenburg, national president of the Ladies' Auxiliary, appointed the various convention committees.

The local committee of ladies escorted the visiting ladies through the various department stores on Thursday morning and in the afternoon a tally-ho ride was given through Fairmount Park to Belmont Mansion, where refreshments and an entertainment were provided. Friday morning was devoted to visiting the various historical points of interest throughout the city and in the evening the ladies were present at the ball in large numbers. The grand march showed off the beautiful gowns to the best advantage and the wives of the national officers came in for a large share of the attention from the delegates.

The Supply Men.

The undisputed opinion of every supply man who attended the convention was that the exhibition was the largest and best ever held in the history of the organization. There were about 120 separate exhibits and each booth was elaborately decorated and well equipped with the special line of engineers' supplies sold by each exhibitor. Packings, valves, boiler compounds, feed water heaters, oils, greases, graphites, gauges, indicators, boiler settings, boilers, stokers, grates, condensers, pumps, boiler and engine accessories, each came in for its share of the engineers' attention.

Past and Present Officers of the National Exhibitors' Association

TOP ROW—H. S. Demorest, F. L. Jahn, Hudson Dickerman, J. M. Chapman, H. E. Stone, C. W. Martin, Jr.

BOTTOM ROW—Frank Morrison, John A. Carson, J. D. Jones, G. D. B. Van Tassell, J. L. McGilvray, C. M. Eddy, H. F. Weinland.

The exhibition space took up the entire two floors of Horticultural Hall and the hall was crowded throughout the week with visiting delegates and local engineers. Souvenirs were liberally distributed and the pleasant relations existing between many supply men and the visiting delegates were renewed.

On Monday evening, a short meeting of the National Supply Men's Association was held at Hotel Walton, at which time a discussion of the uniform height of booths was decided upon for future conventions. Mr. J. D. Jones presided, and he appointed a nominating committee to nominate the officers of the Supply Men for the ensuing year.

The exhibition hall was formally opened on Tuesday afternoon, at 3.30 o'clock. Mr. G. Frank Duemler, secretary of the

local convention committee, introduced Theodore N. Kelsey, national vice-president of the N. A. S. E. Mr. Kelsey spoke of the growth of the exhibition feature in connection with the conventions of the N. A. S. E. and he said that the present collection of engineering appliances and supplies was probably one of the best ever brought together. Mr. Kelsey also dwelt at length upon the educating influence of such an array of exhibits.

Mr. John D. Jones, president of the National Association of Supply Men, responded and thanked Mr. Kelsey for his warm words of approbation. He said that it was ever the effort of his Association to please the members of the N. A. S. E. and he predicted that with the two organizations working in harmony, the future exhibitions would even far outshine the present one.

On Thursday evening, the election of officers was held and the following men were elected unanimously to represent the National Association of Supply Men for the coming year: President, John A. Carson, of A. W. Chesterton Co., Boston, Mass.; Vice-President, John L. McGilvray, Peerless Rubber Co., New York City; Secretary, C. K. Thomas, Lunkenheimer Co., Cincinnati, O.; Treasurer, G. D. B. VanTassel, Westinghouse Machine Co., Chicago, Ill.; Executive Committee, Frank Morrison, Mason Regulator Co., Boston, Mass.; H. S. Demorest, Green, Tweed & Co., New York City; and William D. Purcell, Quaker City Rubber Co., Philadelphia, Pa.

NOTES OF THE EXHIBITS

Of course, the committee had to begin somewhere so the booths were numbered in succession beginning in the southwest corner of the main hall on the second floor, booth No. 1 being occupied by the Westinghouse Air Brake Co., showing Steam, Motor and Belt-driven Air Compressors for stationary and portable service. C. D. Brown and F. W. Nagle were in charge.

A. W. Chesterton & Co. were in booth No. 2 with a swell display of the well-known Chesterton products, including Rubberbestos Sheet Packing, "Combination" Rod Packing, Carson's High-Pressure Rubberbestos Sectional Gaskets, Chesterton's "Combination" Scraper and Brush for cleaning boiler flues and also an exhibit of metal inserted Rubberbestos Sheet 1-32 in. in thickness. The booth was in charge of Mr. J. A. Carson, now president of the National Exhibitors' Association, and Mr. H. D. Raymond. Mrs. Carson and Mrs. Raymond were also present at the Convention and when at the booth seemed to be quite as popular as their husbands. Handsome watch fobs were given away as souvenirs.

Richard Thompsan & Co. showed an exhibit of Thompsan Indicators, Ideal Reducing Wheels, Damper Regulators, Soot Ejectors, etc., in charge of Mr. Richard Thompson.

The George W. Lord Co., manufacturers of Water Purifying Chemicals, had a handsomely furnished exhibit for the entertainment of their engineer friends, from which they passed out a great quantity of souvenirs, including thermometers, trick watches, pencils, fishes, paper files, looking glasses and ladies' garters. The latter were handsome affairs and it is needless to say that there was a great rush for them. The representatives were Captain J. E. Doughty, Mr. Edward J. McCarthy, C. W. Philips, J. Henry Blanchard, Col. N. P. Lane and Mr. V. O. Lawrence.

A sad feature in connection with this exhibit was the announcement late Thursday evening of the death of Mr. Geo. W. Lord, president of the Company. The announcement came as a distinct shock to every one of the Lord representatives present and, of course, the booth was closed up at once and draped in mourning.

The Buckeye Boiler Skimmer Co., of Toledo, Ohio, were represented by Mr. H. A. Little.

Joseph T. Ryerson & Son showed a model of the Continental Boiler, which was in charge of Mr. F. B. Slocum, their New York manager.

Al. Arens, manager of Jenkins Brothers' Chicago store, seemed to be a popular idol with the Western delegates. He said he liked Philadelphia, even if it was hot.

John A. Carson
President of the National Exhibitors' Association

Craig Lippincott, Jr., the coming indicator man, was present and decided the important question of the winner of the indicator which was awarded free by the Lippincott Steam Specialty Co. Mr. Edward Lee, of Albany, was the lucky engineer.

Thomas G. Keogh was present in the interest of the Morehead Return Steam Traps and other specialties which he represents.

E. F. Houghton & Co. showed a handsome exhibit of Lubricating Oils, Greases, Oil Filters, Boiler Compounds and Steam Traps. Also a display of "Vim" packings, both sheet and rod, for every kind of packing service. They were represented by Walter L. Reading, L. E. Murphy, F. R. Moore and William Lindenfelser.

Howard Chemical Co. had a fine exhibit of their "Scale-Off" boiler compound, also some rather remarkable specimens of boiler scale. As souvenirs they gave out a case of court palster, memorandum books, pocket books, coin and card cases, a set of twenty-four souvenir postal cards of all nations with which they do business, and thousands of cigars. Oh! but they were easy! and the souvenir friends flocked around them in bunches. They got about everything in sight, except Hr. Howard's smile—it won't come off. They were represented by Leo Sherman and Harry H. Howald-the president of the Company.

Ward & Upright Engineering Co. showed the Kinghorn Multiplying Disc Valve. They were represented by Mr. Schatz and Mr. Upright.

The Garlock Packing Co. had a handsomely decorated booth in which they showed a full line of Garlock Packings, both fibrous and metallic and sheet packings, including the new TAURIL and sheet, which is said to possess wonderful strength and endurance. They were represented by Messrs. L. E. Adams, W. R. Haggart, A. L. Irving, Elwood F. McDowell, W. J. Taylor, George Noble, F. J. Edmonds, Charles Barnes, B. J. Miller, L. E. Goggin and George Wismer. Souvenir buttons and watch fobs were given out.

Charles Bond had an exhibit of Belting, Pulleys, and a general line of Power Transmission stuff, with Messrs. F. C. Eddleman and Howard MacFern in charge. They gave out a combination pen and pencil which proved a popular souvenir.

The H. W. Johns-Manville Co. showed a line of Kersarge and Moboline Packings, and Sectional Pipe Covering. Their interests were looked after by Messrs. W. L. Miller, W. F. Baird, George N. Simpel and T. J. N. Nicely.

The Lippincott Steam Specialty and Supply Co., and the Indicator Instruction Co., of Newark, N. J., displayed a line of Indicators which was unique in its way, having about 400 instruments tastefully arranged about the booth, making what they claim to be the largest display of instruments ever seen in one place. The feature of their exhibit was a prize offered to delegates registering, this prize being one of their High-Pressure Pattern Indicators, which was won by Mr. Edward Lee. of Albany, N. Y. The Company state that they will send printed matter descriptive of these instruments, on request, and also of their new Take-up device, which attracted a great deal of attention at the Convention.

Philadelphia Electric Equipment Co. showed almost everything electrical. Their star attraction was their "Tantalum" lamp. They were represented by R. C. Bear and J. R. Wilson. Just at the "wind up" of the show they gave out electric flash lights as souvenirs and, of course, they were nearly mobbed, for everybody wanted one.

Diamond Power Specialty Co. exhibited the Diamond Steam Flue Blower, a device for blowing flues from the rear of the boiler, which attracted considerable attention. Their interests were looked after by The Robsmith Specialty Co., of Philadelphia.

Eureka Packing and James L. Robertson & Sons showed a fine exhibit of their products, including their famous Oval Gum Core, Eureka High Pressure and Eureka Square Spiral, Eureka Water Proof and Eureka Flax Packing. Also a handsome display of Robertson-Thompson Indicators, Reducing Wheels and Planimeters. The exhibit was in charge of Mr. Wm. Robertson and an assistant. An interesting novelty in the form of a dice box was distributed as souvenirs.

The Bird-Archer Co., manufacturers of Bird-Archer Boiler Compounds, had a handsomely decorated booth from which they gave out suit case tags, soap books and fans for the ladies, which latter made them very popular. They were represented by Thos. H. Desmond, Thos. Oaks and A. K. Shaw.

The Fisher Governor Co., of Marshalltown, Iowa, were represented by Mr. Wm. Fisher.

The Parmelee Wrench Co. had an exhibit of the Parmelee Girdle Pipe Wrench. Their representative was Mr. Roy Parmelee.

The Empire State Engineering Co. exhibited the Maxfield Engine, the Leeland Oil Cup, Soroceo Fans and Vesterdahl Ice Machines, in charge of Mr. Harry J. Marks and Mr. Allen W. Marks.

The Steel Mill Packing Co. showed their "Hi-Steam" Metallic Packing and Safety Plastic Metallic Packing. The exhibit was in charge of Messrs. Geo. R. Beamer and A. C. T. Stilwell.

The Strong Machinery and Supply Co. exhibited an extensive line of Packings and Engineers' Supplies, in charge of Mr. Stewart R. Brown and Mr. Louis Strong.

The American Steam Gauge and Valve Mfg. Co. exhibited the American-Thompson Improved Indicator with detent motion. Also Pop Safety Valves, Gauges, etc. Harry Brennan and Chas. Creigh were in charge.

The Mason Regulator Co., of Boston, showed a complete line of Reducing Valves, Pump Regulators, etc. Mr. Frank A. Morrison was their representative.

I. B. Davis & Son, of Hartford, Conn., manufacturers of the original Berryman Feed Water Heater, were represented by Mr. Thos. McAdoo, their Philadelphia Manager. Everybody knows Tom.

The Wm. Powell Co., of Cincinnati, had a fine exhibit of White Star Filters and other Powell specialties, including Oil Cups, Sight Feed Lubricators and the Union Removable Disc Valve. Mr. Chas E. McFarland was in charge. C. J. Rainear & Co. are their Philadelphia agents.

The Westinghouse Machine Co. had an exhibit in the interest of Roney Stokers, which was in charge of Mr. Geo. D. B. VanTassel.

Strandwitz & Scott, Sheet Metal Workers, Camden, N. J., were represented by Mr. Jas. Scott.

The Burt Mfg. Co., of Akron, Ohio, were represented by Fairbanks Co., of Philadelphia.

Thos. C. Warley & Co., 221 S. Front Street, Philadelphia, manufacturers of Warley Boiler Cleansing Compounds, were represented by Mr. Warley himself.

The Holmes Metallic Packing Co., of Wilkes-Barre, Pa., were represented by Mr. F. E. Emery.

The American Boiler Economy Co. was represented by Mr. Henry C. Wiltbank, secretary of the Company. Mr. Wiltbank also represented the New England Roller Grate Co., and Jno. T. Lindstrom.

The American Water Softener Co. was represented by Mr. A. C. Tomlinson, Secretary, and A. S. Garrett, Treasurer and General Manager.

The Foster Engineering Co., of Newark, N. J., were represented by Mr. Thos. Brannan, their Philadelphia representative.

Power was represented by Messrs. F. R. Lou, C. E. Dibble, H. K. Fisher, G. E. Sly, L. G. Vogle, Jack Armour and Geo. H. Wellman.

Liberty Mfg. Co. exhibited Liberty Turbine Tube Cleaners, Oil Filters, Blow-off Valves and the Twin Strainer. Messrs. W. A. Darrow, Wm. Owen and C. A. Conn were in charge. A substantial match safe was given as a souvenir.

John A. Robeling's Sons Co. showed a complete line of Wire Rope, and Insulated Wire of all descriptions. Mr. Robert W. Welch greeted the delegates and passed out a small wrench as a souvenir.

Engineers' Review was represented by Mr. A. E. Warner.

The V. D. Anderson Co. showed a line of steam traps of the Anderson improved type, which seemed to attract many of the delegates. The exhibit was in charge of Mr. H. S. Meacham. Mr. Abry and Mr. Meyers were also present.

Chapman Valve Mfg. Co. had a large exhibit of valves in charge of Messrs. Herbert E. Stone, C. F. Chaundy and D. T. Graff. Three-foot rules were given out as souvenirs.

Cleveland Rubber Works exhibited an immense quantity of MARCO packings, effectively displayed and very ably demonstrated by Messrs. W. E. Sanders, R. F. Valentine, J. G. Britzen and T. G. Cooper. A handsome briar pipe was given as a souvenir.

The Lagonda Mfg. Co. occupied a large booth near the head of the main stairway, where they showed a complete line of Lagonda specialties, including their famous Turbine Boiler Tube Cleaner, Tube Cutters, Damper Regulators, Reseating Machines and their Automatic Cut-off Valve, which latter proved a big drawing card. Twenty-four Weinland Turbine Cleaners connected to overhead pipes were kept running constantly during the four days of the Convention. Messrs. H. F. Weinland, J. P. Maloy, J. B. Mellor and Robert Gregory were in charge.

McLeod & Henry Co. occupied an attractive booth immediately at the head of the main stairway, which was in charge of their popular New York representative, Mr. John H. Foote, who proved to be one of the best-known and most popular men in the Hall, and Mr. Frank H. Waite, manager of their Philadelphia Office. The exhibit included a complete boiler and setting, showing the construction and arrangement of their famous Steel Mixture Fire Brick, which is guaranteed to stand 4000 degrees Fahrenheit, and this is said to be the only firm in America who guarantee a fire brick for two years. As souvenirs they gave out handsome rules and lead pencils.

Quaker City Rubber Co. had a large double-sized booth in which they displayed a very complete line of mechanical rubber goods, including their famous "P. P. P." Rod Packing, Ebonite Sheet Packing, Rubber Hose, Belting, Pumps, Valves and many other specialties. The booth, which was handsomely decorated, was in charge of Messrs. Henry Rittenhouse, W. D. Purcell, H. A. Howe and A. D. Thompson. As souvenirs they gave out magnifying glasses, steel rules, pocket mirrors, celluloid tablets, then we lost count. Needless to say, they were popular.

The Crandall Packing Co. had a valuable little corner lot artistically decorated, in which

they displayed a full line of Crandall Packings, including some interesting specialties. They were represented by Messrs. J. M. Chapman, Herbert Self and J. Kaymel. As souvenirs they gave out a pretty little rattan cane, with polished metal handle decorated with red, white and blue ribbons. The rush was fierce while they lasted.

A. S. Cameron Steam Pump Works was represented by Mr. P. E. Leahy, Past-President of the N. A. S. E., who handed out match safes, book markers and pleasant words to the delegates.

The Dearborn Drug and Chemical Works had a double-sized booth immediately in front of the main stage, handsomely furnished, the main feature of which was a magnificent large show-case containing hundreds of samples of Dearborn products, including Boiler Compounds for various waters, Lubricating Oils, Greases, etc. A Juvenile Orchestra was constantly in attendance and their well-known representatives, who are always loaded with jokes and good stories, completed the entertainment of the crowd. Among those in charge were Messrs. Wm. B. McVicker, C. M. Eddy, G. F. Duemler, W. T. Wheeler, Dan Delaney, Jos. N. Gregory, A. C. Crouch, J. Breckerleg, S. B. Bennett and P. H. Hogan. Hundreds of souvenirs were distributed.

The Peerless Rubber Mfg. Co. had a handsome large booth decorated with palms and silk ribbons, making a very pretty effect. Over $2500 worth of Rainbow Packing was used in forming the exhibit, and in addition to this there was a large display of other Peerless Specialties, including Peerless Piston Rod Packing, Eclipse Sectional Rainbow Gaskets, Peerless Sheet Rubber Tiling, Hose, Belting and many other mechanical rubber specialties manufactured by this popular concern. As usual, the Peerless Souvenirs were extraodinarily fine and were persistently sought by those in attendance. Each of the delegates was presented with a valuable leather pocketbook, and each lady with a handsome fan. This was in charge of Mr. J. L. McGilvary, the popular and busy secretary of the Supply Men's Association, Mr. Stephen Roberts, Mr. P. G. Staunton and Mr. F. O. Donnell.

Lake Erie Boiler Compound Co. had a booth which seemed to be a beehive of industry, those in charge working just as earnestly as though it paid. They seemed to have several tons of souvenirs that they were trying to get rid of as rapidly as possible. Among these were trick match safes, with a perpetual calendar good for a lifetime and three years longer, 12-inch steel rules, and nickle plated pocket wrenches. They were represented by E. C. Schwingel, W. W. Horner and John P. Patterson.

The Southern Engineer was represented by W. R. C. Smith, J. Willett Smith and J. Haskins Smith.

The International Correspondence Schools passed out a large amount of attractive and interesting literature showing how to increase one's knowledge of engineering at home. They also gave out a very pretty oxidized silver monogram watch fob as a souvenir. Their representatives were H. G. Lembert, W. B. Davis, H. C. Dilworth and H. R. Reist.

Watson & McDaniel had a very attractive exhibit of Steam Traps, Separators, Exhaust Heads and Pump Governors, in charge of Mr. Jas. Watson, Jr., and Mr. Fred L. Jahn.

Greene-Tweed & Co. had a booth fixed up as pretty as a parlor, in which they displayed a quantity of Palmetto Packing of all sizes and the Exacto Packing Cutter, a new tool for cutting packing any size desired and which is unquestionably the best thing for the purpose ever made. They were represented by H. S. Demarest, F. E. Ransley and B. L. Bulkley. As souvenirs they gave out hundreds of metal chirping bugs, which proved highly popular and they could be heard chirping all over the Hall.

The Fairbanks Co. showed a large display of Cross Oil Filters, American Oil Filters, Wright Water Columns, Austin Separators and other specialties. Mr. Chas. P. Sandville was in charge.

Schutte & Koerting Co. had a large exhibit of Valves, Injectors, Jet Condensers and other appliances using the steam jet as the actuating force. They were represented by Messrs. J. J. Gessleman and F. M. Foreman.

Phillip Carey Mfg. Co. showed a complete display of Pipe Coverings in charge of Messrs. Frederick Collins, Jr., John Lindauer, Wm. McDade and James B. Colladay.

United States Metallic Packing Co. showed a 14-inch Packing for stationary work, which attracted many engineers. This particular packing was built for the American Steel and Wire Company. They were represented by Messrs. Elliott Curtis, Chas. W. G. King and F. J. Kieley.

The Buckeye Engine Co. occupied the first booth to the left of the main entrance, which was handsomely decorated with a fine collection of framed engine photographs and from which Mr. C. H. Wickes distributed buttonhole bouquets to everybody. That Mr. Wickes was immensely popular goes without saying. Another feature of this exhibit which was highly interesting was a model of a new type of Indicator just invented by Mr. J. W. Thompson, the aged inventor of the original Thompson Indicator.

Reagan Grate Bar Co. occupied the first position to the right of the main entrance, where they showed a complete Reagan Shaking Grate. Mr. Reagan himself was present most of the time and the exhibit was generally surrounded by a crowd of delegates, who seemed interested in the operation of the grate. Mr. Reagan claimed that this grate would do 25 per cent. more work with bitumious coal than any other shaking grate made.

H. B. Underwood & Co. had a prominent booth in the main entrance, at which they showed their complete equipment for reboring engine cylinders in position, several sets of St. John Packings and other tools and equipment used in their general repair work. Messrs. Ed. J. Rooksby, Hiram D. Griffith and Chas. Ralph were in charge. Key rings were given out as souvenirs. Before the exhibition closed, a California delegate purchased the boring bar and had it shipped direct to the coast.

Home Rubber Co. exhibited "N. B. O." and "O. I. M." Packings and Foley's Combination Cap Valve. Messrs. A. R. Foley, J. C. Berrang and C. Bainbridge were in charge.

Adam Cook's Sons, manufacturers of Albany Grease, had a nicely decorated booth where they showed samples of Albany Grease and gave out pen wipers and pencils as souvenirs. Messrs. G. E. Tanberg, J. W. Crane and Geo. Baum were in charge.

D. W. Patterson exhibited the Vigilant Feed Water Regulator and Pump Governor.

Burrows Mfg. Co., of 73 Warren St., N. Y., showed models of the Burrows Boiler Feed Regulator, Pump Governors, Steam Traps, Damper Regulators and Back Pressure Valves. Also a new cast bronze float to take the place of soldered copper floats and which can not leak and fill up. Those in charge were Messrs. Geo. W. F. S. Smyth, Conrad Swoboda and A. E. Burrows.

James McCrea & Co. exhibited the Climax Pipe Clamp, "H. H." Steam Trap, and Rowe Feed Water Regulator. Mr. M. B. Skinner was in charge and gave out a very handsome paper weight as a souvenir.

Leavitt Machine Co. showed a Morse and Dexter Valve Reseating Machine. They were represented by Messrs. F. A. Dexter and J. L. Smith.

Harrison Safety Boiler Works had an exhibit which was conspicuous for its neatness, at which they showed models of the Cochrane Feed Water Heater and Cochrane Separator, both well-known specialties of unquestioned merit. Mr. J. E. Harris was in charge and gave out cigar holders as souvenirs.

Morgan & Wright showed a very complete line of Rod and Sheet Packings for every kind of service, the chief attraction among which was their White Seal Sheet Packing. The exhibit was in charge of Mr. Hudson Dickerman.

Jenkins Brothers occupied a cosy little corner, which was handsomely decorated and surrounded by palms and tropical plants, making it one of the neatest looking exhibits in the Hall. Samples of Jenkins Valves, '96 Packing and other specialties were shown by their popular representatives, Messrs. H. G. Logan, Chas. N. Martin, Albert T. Arens, J. C. McHugh and W. G. LeCount.

Albert Schade showed a complete line of engineers' and mill supplies, representing Ashton Valve Co., Eastwood Wire Mfg. Co., Thos. P. Ford Co., Greene-Tweed & Co., Spencer Regulator Co., and Syracuse Tool Co.

Ashton Valve Co. had a handsome exhibit of Pop Safety Valves, Pressure and Vacuum Gauges, in charge of Messrs. H. H. Ashton, Columbus Dill, L. M. Lewis and Mr. Corbett.

The Taylor Publishing Co. was represented by Messrs. A. L. Rice, Editor, E. R. Shaw, S. E. Cole and S. W. Anness.

Revere Rubber Co. exhibited their Black Hawk and Usudurian Sheet Packings and a complete line of mechanical rubber goods. Their entire booth was built of rubber, representing some artistic work on the part of their popular representatives, Mr. Geo. C. Penboss, Mr. A. E. Waugh and Mr. F. W. Sparkman. As souvenirs they gave out memorandum books bearing a portrait of Paul Revere on the cover and metal paper weights in the form of a turtle, being a fac-simile of the trade mark on Usudurian Sheet.

The Wright Mfg. Co. and Austin Separator Co. had a fine exhibit of Steam Traps, Water Columns and Separators, in charge of Mr. H. H. Humphreys.

Johnston Nolan showed a new blow-off valve, which seemed to interest a great many of the delegates. The booth was in charge of Mr. George W. Sproehnle, who demonstrated the merits of the valve very effectively.

U. S. Graphite Co. had a large exhibit of their No. 205 Lubricating Graphite, also Mexican Graphite, Pipe Cement and other graphite products in charge of Messrs. T. H. Williams and Isaac Wood.

Walch & Wyeth exhibited the Erwood Straightway Swing Gate Back Pressure and Check Valve, which was one of the newest and most interesting devices at the show. Mr. Walch was in charge.

The France Packing Co. showed a large and very complete line of Packings, both metallic and fibrous, including many sets of their well-known Metallic Sectional Ring Packing and also the France Compression Grease Cups. As souvenirs they gave out trick watches, the explosions from which, mingled with that contagious laugh of Mr. France, made their booth a lively spot. A. W. France, A. K. Safford and J. K. Ruttherford were in attendance.

C. Lee Cook Mfg. Co. showed a display of Cook's Metallic Packing, showing part of a shipment of the Carnegie Steel Co. Mr. Robert E. Baldwin represented them. Key rings were given out as souvenirs.

The Jos. Dixon Crucible Co. exhibited Graphite Brushes, Pipe Joint Compound, Graphite Greases, Silica Graphite Paint and Graphite Brushes for Dynamos. They were represented by Herman Price, Lewis F. Lyne, W. H. Keen and J. J. Tucker. Dixon lead pencils were given out as souvenirs.

John R. Livezey had the largest display of Pipe Coverings and Insulating Materials shown at the Convention, among which Nonpareil Cork was the star attraction, being recognized as the most efficient material yet found for cold storage insulation, as well as for steam, water, etc. He also showed a full line of Asbestos Magnesia Air Cell and Wool Felt Coverings. Mr. H. E. Souders, Mr. M. Neelley and Mr. Livezey were in charge, passing out lead pencils and cigars freely to the visitors.

The Philadelphia Lubricator and Mfg. Co. showed a large display of Philadelphia Grease Cups. The feature of this cup is that it feeds by compressed air and it seemed to interest the engineers. They also showed their line of Sight Feed Lubricators and the Philadelphia Cylinder Lubricator, which latter when connected with the main steam pipe will lubricate as many cylinders as are supplied by said main. L. T. Mattes and J. F. Lewis were in charge. Packs of playing cards were passed out as souvenirs.

O. F. Zurn Co. had a nicely furnished booth, in which they showed samples of their line of Lubricating Oils and Greases, Peerless Boiler Compound, Oleaqua Hydraulic Compound, Zurn Oil for Automobiles, White Waste, and other engineering specialties. They were represented by Messrs. Chas. J. Curran, J. D. Kelley, J. M. Zurn, L. Donges and Geo. W. Childs.

The Keystone Lubricating Co. occupied a double-sized booth on the first floor and did about everything possible for the convenience and entertainment of the delegates. A small barrel of ice water was kept constantly on tap. A public stenographer to write letters for the delegates was maintained in the booth throughout the Convention, and many of the delegates availed themselves of this service. A private letter box was also maintained in which the delegates were invited to drop their mail unstamped. This mail was collected by a special messenger every hour, properly stamped and delivered to the Post Office. Those in charge also received applications for free samples of Keystone Grease and cups to be expressed to the delegate's home address, and gave out engineers' caps, an oxidized gun metal match safe and a beautiful silicated board tablet for the ladies.

The C. H. Wheeler Mfg. Co. had the best exhibit of heavy machinery at the Convention, including a large Surface Condenser, a Mullan Suction Valveless Air Pump, Tubular Feed Water Heaters, Boiler Feed Pumps and Fire Pumps. They were represented by F. S. Broadhurst and J. B. Nibbling, Jr.

The Hoppes Mfg. Co. showed Exhaust Steam Feed Water Heaters, Live Steam Feed Water Purifiers, Separators and Exhaust Heads. Those in charge were S. E. Ware and C. B. Ross.

Parker Boiler Co. showed a model of a Parker Boiler and complete set of headings. They were represented by T. C. Craig and F. G. Borgenshausn.

The Allis Chalmers Co. had a large space handsomely decorated with tropical plants and framed pictures of engines. Illustrated bulletins and other interesting literature were distributed by Messrs. Guy Strafer, F. S. Gibson and F. L. Richie.

New York Belting and Packing Co. showed a full line of Rod and Sheet Packings, Belting, Hose and general mechanical rubber goods. They were represented by Messrs. W. R. Wood, L. L. Taylor and W. A. Rinn.

Atlas Engine Works had a select little spot furnished in mahogany, turkish rugs and ferns, from which catalogues and other illustrated matter were distributed by Messrs. Frank Ferguson and G. R. Harvey.

Crane Company were represented by Mr. Fred H. Russell. They showed an exhibit of Valves and Crane Fittings.

State Mfg. Co., of Cleveland, O., had an exhibit of Metla-Cota, claimed to be the peer of boiler cleaners. They were represented by Mr. J. B. McDonald.

Cancos Mfg. Co. showed a large stock of Black Squadron Packings for every service. H. Harmsted, Samuel Best and Geo. Costello were in charge.

Cling-Surface Co. gave an interesting demonstration, showing that a belt treated with Cling-Surface and running SLACK will do twice as much work as a TIGHT belt not treated with Cling-Surface. They were represented by Chas. F. Chase, D. P. Boersma and William D. Young.

The Underfeed Stoker Co. of America were represented by Messrs. William T. Jordan, J. M. Roe, Thomas Beith and Charles S. Crowell.

A. Leschen & Sons Rope Co. showed a complete line of "wire" rope. They were represented by Charles C. Good.

Hicks & Timberlake were represented by W. W. Hicks, showing Hicks's Ball Bearing Gland for gauge glasses.

Hills-McCanna Co., manufacturers of Force Feed Lubricating Pumps and other specialties, were represented by Mr. Robert E. Hills.

Scully Steel & Iron Co. exhibited the Ruggles Perfection Flue Cleaner, one of which was presented to each representative of the Association. Mr. C. M. Ruggles was in charge.

The Strong-Carlisle & Hammond Co. showed the Squires Feed Water Regulator, Steam Traps, Pump Governors and Reducing Valves. They were represented by A. B. Pinney, F. K. Evans, L. P. Strong and Homer Walpley.

Cyrus Borgner Co., of Philadelphia, showed a complete line of fire bricks of every shape and variety. The exhibit was in charge of

Messrs. C. A. Dickel, George H. Dickel, Jr., and Fred W. Gerhard.

William C. Robinson & Son Co. showed a full line of lubricating oils in charge of Messrs. Stanley, W. Rusk, Victor Kummerer. Theo. D. Star, Chas. S. Wood and Howard D. Pfeiffer.

Engineers' Supply Co., of Pittsburg, was represented by T. C. Green.

The C. A. Dunham Co. showed a large exhibit of their steam traps. One of the star features was the Dunham Steam Radiator Trap for low pressure vacuum or vapor heating, which is a new thing. It made a decided hit with the delegates.

E. P. Allen Valve Co., of Chicago, showed a new and interesting Air Valve which attracted much attention from the engineers. Mr. E. P. Allen himself demonstrated its merits in a convincing manner.

The Kent Lubricating Co., Waukesha, Wis., had an exhibit of their lubricating compounds, in charge of Mr. L. H. West.

The American Ferrofix Brazing Co. showed samples of their work in brazing cast iron and aluminum, the latter being an entirely new discovery and which would seem to possess immense possibilities for electric work. They were represented by G. H. Taylor, W. L. Donaldson and E. P. Smith.

Neemes Brothers showed an interesting exhibit of the Neemes Bros. Improved Shaking and Dumping Grate.

The Paul B. Huyette Co., Betz Building, Philadelphia, showed Reliance Feed-Water Columns, Steam Traps and Solderless Floats, also the P. B. H. Quick-Closing Water Gauge, the P. B. H. Gauge Cock and the Tornado steam boiler flue cleaner. They were represented by Messrs. Thos. M. Shaw and Paul B. Huyette.

The Eclipse Feed Water Heater and Purifier Co. were represented by Mr. C. Kieren.

Philips Pressed Steel Pulley Works, of Philadelphia, were represented by Mr. E. H. Marot.

American Oil Filter Co., of Philadelphia, had an exhibit showing their new Oil Filter, which attracted considerable attention.

Milwaukee Metal Co., of Milwaukee, showed the Werder Graphite and Oil Pump for cylinder lubrication, in charge of Mr. L. H. West.

Consumers Ammonia Co., Drexel Building, Philadelphia, was represented by Mr. J. H. Morris.

Acme Chemical Co., of Philadelphia, had an exhibit of Champion Boiler Compound. They gave out booklets printed in the new abbreviated language as "rekomended bi Profeser Ruzfelt."

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

Those who happen to be interested in the attractive advertisement of the Murray Iron Works Co. on the front cover of this issue and who have not a copy of the new Murray catalogue, should write for a copy at once. It is one of the most complete and valuable catalogues that has come to our notice for a long while and is an excellent guide for those contemplating the purchase of steam engines, boilers or feed-water heaters.

A new catalogue just received from the Direct Separator Co., 220 Marcellus St., Syracuse, N. Y., will be of special interest to all those who are troubled with wet steam or who appreciate the value of eliminating moisture from the steam and protecting the engine from water. In this catalogue the whole subject is discussed in an interesting manner and the steam, oil, ammonia and boiler separators manufactured by the firm, are described in detail and fully illustrated. Copies will be mailed upon request.

The Reagan Grate Bar Company advise us tnat they have just refused an order for some ten thousand dollars worth of Reagan Shaking Grates. The reason for refusing the order being that the prospective purchaser desired the grates to be built 8 feet long and Mr. Reagan contends that no grate can give satisfaction at so great a length, particularly with bituminous coal.

Billy LeCompte, of Jenkins Brothers, has been found out at last. The firm are on to him, and after eight years' dodging around the jungles of Baltimore and Washington, he has been promoted to the main store in New York, and "Billy" will have to work. It almost makes us feel sad, though we really think that a little exercise will do him good. The engineers of Baltimore and Washington will miss him, but their loss will be New York's gain, for "Billy" is a thoroughbred at work, as well as at play.

The Home of the D. T. Williams Valve Co. is in Cincinnati. Please stick a pin here so that you will remember that it is not in Cleveland, even if their advertisement in our September issue did give the latter as their address, that was a mistake of our printers, and the Williams Co. were so good natured about it, as they are about all things, that we want to impress upon our readers that the home of the D. T. Williams Valve Co. is Cincinnati, Ohio.

Jerguson Manufacturing Co. have succeeded the William T. Bonner Co., of 221 Columbus Ave., Boston, Mass. They will carry a full line of "Wiltbonco" Engineering Specialties. Mr. P. A. Jerguson is at the head of the new concern. Mr. Jerguson was formerly superintendent for the Bonner Company and is admirably fitted for manufacturing the line of special appliances which he proposes to market.

James L. Robertson & Sons, Inc., and Eureka Packing Co.'s sales department have removed from 204 Fulton St., to 48 Warren St., New York, where they will have largely increased facilities and a much better location for taking care of the increased demand for Eureka Packings and also the Robertson-Thompson Indicators, Victor Reducing Wheels, and their entire line of engineering specials.

Eureka Packings are now made in several different styles for every variety of packing service. The old friends of "Eureka" who have not seen the new styles, should write for catalogue. Don't forget the new address at 48 Warren St.

The Reagan Grate Bar Co., 205 North Front St., Philadelphia, have just received an order from the Boston Elevated Railway Co. for Five Thousand Dollars worth of Reagan's Shaking Grates which order came to them unsolicited. The Company claim that their grate will do 25 per cent. more work than any other grate with bituminous coal. This seems like a strong claim, but the Company is willing to back it up with a strong guarantee. Illustrated circulars and prices, also a copy of the contract and guarantee furnished by the Company will be mailed to any reader of "The Practical Engineer," upon request.

Wetzel Mechanical Stoker Co., 147 E. State St., Trenton, N. J., have issued another large new catalogue describing the Wetzel Mechanical Stoker in detail. This is one of the most complete and useful stoker catalogues that has ever come to our notice and it should be in the hands of every engineer who is interested in mechanical stoking. It contains a number of handsome illustrations showing the Wetzel Stokers installed and telling of the results obtained through their use. A copy of this catalogue will be sent to any one writing the Company at the above address.

The General Specialty Co., of Buffalo, N. Y., report a large demand for their boiler scale removers. Among recent orders are included The American Sheet and Tin Plate Co., Carnegie Steel Co., United States Zinc and Chemical Co., Colorado Fuel and Iron Co., Lackawanna Iron and Steel Co., and the E. I. PuPont Co.

Mr. C. A. Denniston has accepted a position as manager of Keystone Lubricating Company's Chicago office at 1102 Tacoma Bldg. Mr. Denniston was formerly with McMaster-Davis Supply Co., of Chicago, and is favorably known to Chicago engineers.

Mr. W. A. Taylor has been placed in charge of the Kalamazoo office of the Keystone Lubricating Co., in the Pratt Bldg., Kalamazoo. Mr. Taylor is an old engineer of 39 years' practical experience. He was for a long time engineer of the Bryant Paper Co., of Kalamazoo.

A new catalogue describing the Copes Feed Water Regulator and Pump Governor has just

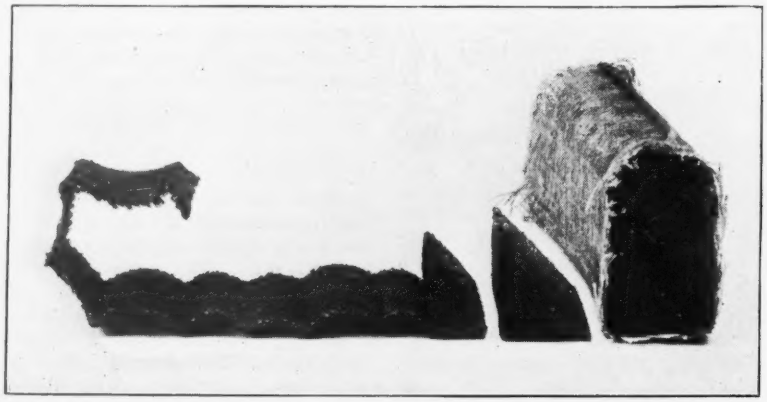
been published by the American Boiler Economy Co., 1001 Chestnut St., Philadelphia.

Rubberbestos Metal Insertion Sheet Packing is now produced in thickness of 1-32 inch. It was deemed impossible to make metal insertion packing this thin, but the manufacturers have at last been successful, after many experiments. A sample of this packing has reached us, and it certainly has the appearance of being a very strong packing for nice joints, as well as being very flexible and adjustable.

A sample of Rubberbestos Metal Insertion will be mailed to anyone interested on application to A. W. Chesterton & Co., 64 India St., Boston, Mass.

Marco Diagonal Packing.

The wedge of this packing is made by wrapping one-ply about itself and molding it into wedge form instead of cutting the wedge from a slab of the requisite thickness. This results in a wedge in which the corner is an integral part of the whole structure and cannot peel off as do the narrow sections of fabric held on simply by the rubber in the ordinary diagonal



packing. Although a molded wedge, it is still very flexible and must wear out to go to pieces. It cannot disintegrate and go through the stuffing box into the cylinder.

MARCO diagonal packing is made with either a flax or duck cushion for low or high pressure. It is thoroughly lubricated throughout. It is made by The Cleveland Rubber Works, of The Mechanical Rubber Co., 74 Lisbon St., Cleveland, Ohio. A catalogue will be mailed to those sending their name and address.

The H. A. Rogers Company, 19 John Street, New York City, report that the local railroad demand for track and machine shop supplies is extremely heavy.

"Combination" packing, manufactured by A. W. Chesterton & Co., of Boston, Mass., seems to merit its name, being a combination of ideas generally regarded as desirable in packings. The manufacturers are having a particularly large business at this time from the mining trade, who find it especially adapted for their use.

The Burt Mfg. Co., 204 Main St., Akron, Ohio, have issued a new 64-page catalogue describing their full line of oil filters, exhaust heads, and ventilators. It is illustrated throughout with a fine lot of engravings and gives sizes, capacities and full detailed information that will aid the purchaser to an exact understanding of his requirements. A copy will be mailed free to any one writing the Burt Company.

Modern lubrication of engine bearings is increasing in interest and is a noteworthy feature in the equipment of up-to-date engine rooms. Leading mechanical engineers are specifying oiling systems on account of the economy with which oil is used, the saving of time in attention over the old methods, saving of oil in handling, as with an oiling system it is only necessary to empty the contents of a barrel direct into the system, all of which combines to simplify conditions. Among the concerns who have purchased White Star Oiling Systems from the Pittsburgh Gauge and Supply Co., Pittsburgh, Pa., during the past few weeks are: The Page Manufacturing Co., New Bedford, Mass.; Merchants' Ice and Coal Co., St. Louis, Mo.; Columbia Improvement Co., Columbus, Ga.; Atlantic Electric Light and Power Co., Atlantic City, N. J.; Power and Mining Machinery Co., Cudahy, Wis.

A fine booklet describing the White Star system in detail will be mailed to those interested.

Students of the International Correspondence Schools to Join in a Big Celebration.

Students of the International Correspondence Schools are much interested in the celebration of the fifteenth anniversary of the Schools, which is to be held in Scranton, Pennsylvania, on October 16th.

It has been nearly 15 years since Thomas J. Foster, then editor of a newspaper in Shenandoah, Pennsylvania, introduced a method of teaching through the mails by means of special home-study text-books and a system of direction and correction of students' work, the object of which was to enable the coal miners of Pennsylvania to pass the required examination for mine foreman. Although the enterprise was of great interest in the mining communities, not even the founder then dreamed that his plan was the creation of a new educational system that was to turn the world into a vast class room and afford the means by which practical, money earning knowledge in almost every line could be carried to the thousands that could not give up work or leave home to secure education.

The day will be taken up with appropriate exercises and an interesting exhibit of the Schools at work preparing and printing home-study text-books and correcting the recitations of students sent in from every part of the civilized world. A banquet to the guests will be given by the Schools in the evening.

GRAPHO
SOMETHING NEW
A new preparation for enriching oils.
Will suspend in oil.
No more Hot Journals.
Engineers who have tried same claim it to be the best yet.
SEND FOR SAMPLE
A trial will convince you
AGENTS WANTED
GRAPHO MFG. CO.
Cor. Frank and Commercial Sts.
ROCHESTER, N. Y.

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address
FRANCE PACKING Co., Tacony, Phila., Pa.

PATENTS Watson E. Coleman, Patent Attorney, Washington, D. C. Advice free. Terms low. Highest ref.

PATENTS Procured ISEDORE S. PRENNER, E.E. Attorney-at-Law, Solicitor of Patents, Consulting Engineer, Law, Patent and Engineering Cases.
Room 1108 Betz Building, Philadelphia.

PATENTS PROMPTLY SECURED. Highest references from prominent manufacturers. Write for Inventors' Hand-Book, SHEPHERD & PARKER, 186 Deitz Building, Washington, D. C.

WANTED—Agents in every state to sell a new (paste) packing as a side line. Used anywhere in place of sheet packing at one-fourth the cost. Liberal commission. WOODARD PASTE PACKING CO., Owosso, Mich.

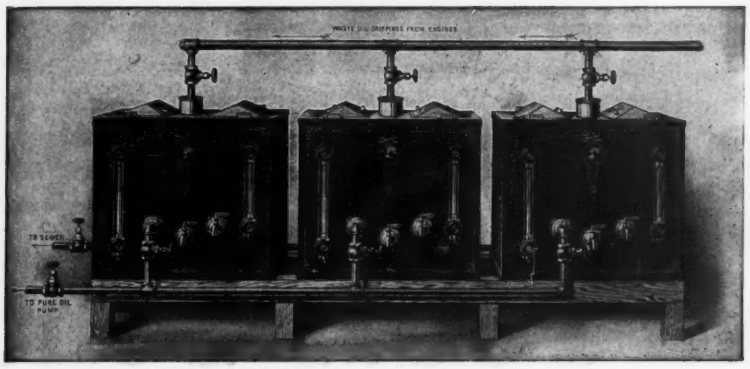
WANTED—A practical Heating Engineer, familiar with New York City Contract work to take charge of Heating Department in a first class Plumbing Establishment, must be familiar with Hot Water work and High Pressure Steam work and handling of men. Salary and interest in profits. State full experience and conditions expected. Address, THOMPSON, care of The Practical Engineer.

WANTED—Engineers and Mechanics to make big money selling O. K. Hand Soap. A 10 cent can will instantly remove more dirt and stains from the hands than 4 cakes of any soap made, and it will not injure the most delicate skin. Sample free. O. K. HAND SOAP CO., 570 Columbus Ave., Boston, Mass.

GOOD SALESMEN WANTED — for a patented specialty selling for $50 and $75, needed in all manufacturing plants. May devote entire time, or sell as side line. Some of our representatives average $15 a day. Some more. Write at once to POWER SPECIALTY CO., Arcade Building, Detroit, Mich.

WANTED—Good Steam Specialty Salesmen in every city to handle a high grade appliance for which there is a live and growing demand. Large profits. Address CORPORATION, care The Practical Engineer.

A Method to Convince Yourself That You Need An Oil Filter



THREE UNITS CONNECTED AND OPERATED AS ONE FILTER

Just instruct your engineer to collect the waste oil for a month or two and store it in a barrel. You'll be convinced then.

The Unit Oil Filters are the result of 15 years' continuous effort to produce the most modern filter on the market. The fact that we've sold over 20,000 during this period speaks eloquently of our success. Each "Unit" is 42 inches long, 28 inches wide, 36 inches high, with a filtering capacity of from 175 to 225 gallons every 24 hours.

"Units" can be operated together or separately. Additional "Units" can be installed when conditions demand it. Carnegie Natural Gas Co., of Pittsburg, Pa., says "We beg to advise that the 'Unit' Oil Filter purchased from you and installed at our Waynesburg Gas Compressing Station some time since is reported by our Chief Engineer as doing excellent work"

We recently installed Units for Singer Mfg. Co., Baldwin Locomotive Works, Ashland Steel Co. (3) Mutual Life Insurance Co. (2); also in the Washington Post Office building and Spreckle Building, San Francisco.

Remove Dirt and Grit From Your Lubricating Oil

Use a Cross Oil Filter it strains the oil through waste, then washes it in pure warm water, separating all impurities, making it possible to use the oil over and over again. Requires very little attention after starting, and—beyond a few cents per year for waste—is operated without expense.

Cannot clog, has nothing to break or get out of order.

Send for copy of our new 64 page catalogue describing our line of Oil Filters, Exhaust Heads and Ventilators.

THE BURT EXHAUST HEAD

prevents drenching, disfigurement and rotting of the roof.

The Edison Storage Battery Company says: "The Burt Exhaust Head which we have had in use for about five months, serves its purpose admirably and is giving entire satisfaction."

That's the way everyone who uses a "Burt" feels.

The Burt Mfg. Co. Largest Manufacturers of Oil Filters in the World. 204 Main Street, AKRON, OHIO, U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors

REPAIRS TO

NO MATTER WHE

Men *and* Tools Sent to all

WE HAVE the best equipped engine repair shops, and the largest and b America. For thirty-six years we have made a specialty of repairs to equipment. Our men have grown up in the business and know how

WE HAVE SPECIAL TOOLS F RIGHT IN YOUR EN

Cylinders rebored in position; Valves reseated in position; Commutators turned

WRITE, PHONE OR WIRE US

H.B.UNDERW

1025 HAMILTON STREET, - - -

TO ENGINES

WHERE THEY ARE

to all parts *of* the Country

largest and best force of expert engine repair men to be found anywhere in repairs to Steam Engines, Steam Pumps, Dynamos and other power plant know how to handle the most difficult jobs with speed and accuracy.

OLS FOR DOING THE WORK UR ENGINE ROOM

tators turned off in position. Crank shaft journals turned off in position.

WIRE US DAY OR NIGHT

RWOOD & Co.

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IT SHOULD BE IMPORTANT TO ENGINEERS AND STEAM USERS

to know that the formulas of

WARLEY'S BOILER CLEANSING COMPOUNDS

are founded on sound chemical principles, and that only the purest grades of chemicals obtainable, regardless of cost, are used in the preparation of these goods, which have now been on the market throughout the United States and Canada, and in many other foreign countries as well, for a great many years, and they are now well and favorably known to thousands of Engineers and Steam Users as Boiler Cleansing Compounds that positively remove incrustation or scale and prevent corrosion and pitting in steam boilers, without doing any injury to the boilers, or their fittings, or to any goods in course of manufacture while using the live steam from the boilers with these Compounds in use therein.

These Compounds are varied to suit the individual needs of steam users, and the grade required can be determined when we are furnished with a small piece of scale from the boiler in which the Compound is to be used, a piece weighing about two ounces will be large enough for our purpose.

Send for Blue Book "Questions and Answers for Engineers, etc.," which we will mail to any Engineer, free, who is in charge of a steam boiler, and who will give us the name and address of firm by whom employed and send us a small piece of scale from his boiler, also mention this paper. Address :—

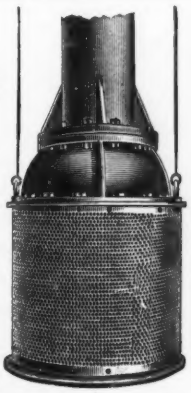
No. 221 South Front Street **THOS. C. WARLEY & CO.** **PHILADELPHIA, PA.**

We also carry a full line of High Grade LUBRICATING OILS and GREASES. A trial order solicited.

The Continuous Service

Foot Valve

Water can be taken continuously and without interruption from streams and ponds that are full of leaves, twigs, fish, sticks, paper and other refuse.



Outer Screen resting on bottom plate

NO STOPPAGE FOR CLEANING

The outer screen is raised by ropes or chains for cleaning.

Outer Screen Drawn part way up on suction pipe

When outer screen is lowered into position the knives at top and bottom scrape the outer surface of the inner screen and clean it.

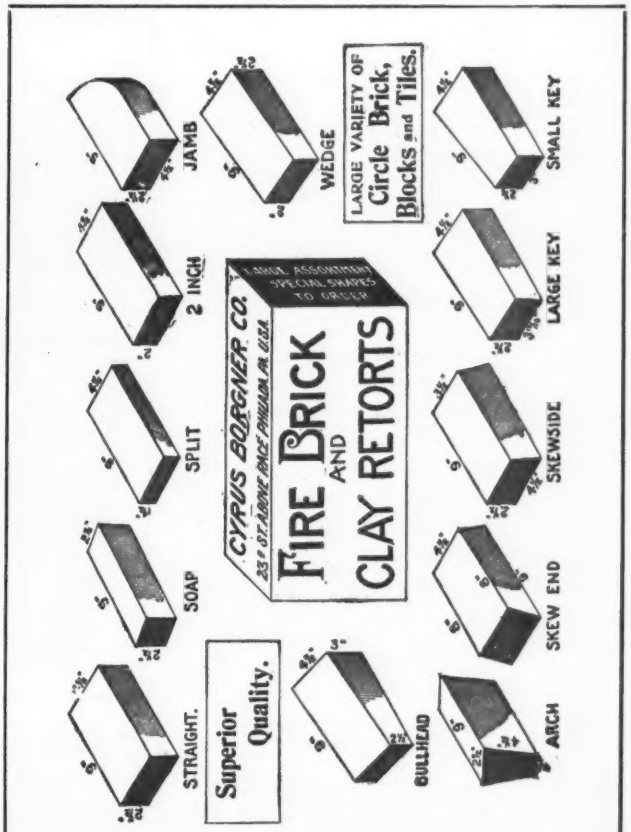
The suction pipe extends to within a few inches of the bottom plate of valve, thus permitting of successful operation in shallow water.

WRITE FOR PRICES

The

Newman Mfg. Co.

26 Cortland St., New York



Every Engineer

desires to operate his plant with the utmost practicable economy.

Every Employer

is anxious to keep the expense account just as low as possible.

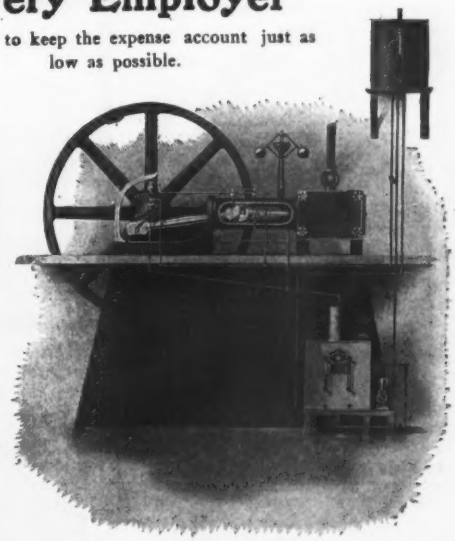
In a power plant where the

White Star Continuous Oiling System

is in use, the saving of oil is astonishing from the start and and becomes fairly astounding as the weekly items pass into the monthly totals, and the monthly totals mount into yearly aggregates showing

REDUCTIONS OF FULLY ONE-HALF

The savings begin with the first minute the system is in operation. We have been collecting facts and figures on the subject which we will be pleased to send, together with booklet "F" which illustrates and describes our method of perfect and economical lubrication of engine bearings. Send for it.



Pittsburgh Gage & Supply Co., Pittsburgh, Penna.

Dixon's Graphite Lightens YOUR Work

It permits cutting down of oil supply, that's one way.

It makes piston packing wear longer, that's another way.

It renders cutting of bearing surfaces absolutely impossible always

Free Sample, 96-C, awaits your request.

JOSEPH DIXON CRUCIBLE CO.
JERSEY CITY, N. J.

Please Ponder This

There is not in any department of your plant a single mechanical improvement that did not displace what you (or your father or his) once regarded as the "sure enough" best thing out; isn't that so?

"LEVIATHAN BELT"

is precisely such a supplanter for the reason that it saves a lot of money by outlasting two or three rubber belts, working on the same job.

Other people say this of it in a booklet that we'd be glad to mail you. Shall we?

MAIN BELTING COMPANY
Sole Manufacturers
1225-1235 Carpenter St. Phila.

55-57 Market Street, CHICAGO
40 Pearl Street, BUFFALO
120 Pearl Street, BOSTON
309 Broadway, NEW YORK

Red Seal Boiler Compounds

RED SEAL BOILER COMPOUND

have been on the market over 13 years. Its sales are constantly increasing. Why? Because its quality and effectiveness are understood by intelligent engineers.

MANUFACTURED BY

THE CHERRY CHEMICAL CO.
No. 10 North 19th St., Philadelphia, Pa.
OLIVER BRADEN, Manager Write for Circulars

The Best Lubricant

AIR MICA FLAKE FLOATED

Use it once and no other lubricant will ever satisfy you Greatest lubricant ever discovered. Try it on the worst bearing you have, or in your cylinder.

SAMPLE FREE
O. & W. A. WORNER
1529 Porter St. Philadelphia, Pa.

STEAM FITTING

if not properly done, in any plant, will cause the engineer a great deal of trouble, and his employer unnecessary expense. Many years of practical experience and a force of competent assistants enables me to guarantee absolute satisfaction.

WILLIAM MILLIGAN, Shop, 726 Sansom Street, Philadelphia, Pa.
'Phones: Bell-Walnut 1271 a
Keystone-Main 1-71
JOBBING A SPECIALTY

THE GENUINE GANDY
PATENTED 1877

GIVE THE ENGINE A CHANCE

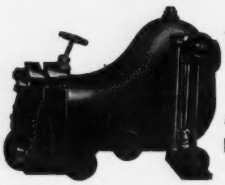
to show what it can do when over loaded, — Get the "old man" to buy Genuine Gandy neverslip belting and see what an improvement there'll be in the efficiency of the plant, its cheap enough, costs only one fourth what leather belting costs.

Let us send you our booklet "Experience with Gandy", its worth reading.

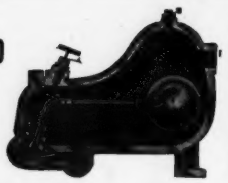
GANDY BELTING CO.
BALTIMORE, MD.

GENUINE GANDY GANDY 6 PLY GENUINE GANDY

McDANIEL Improved Steam Trap



All the working parts are connected to the bonnet and are removable with it, making it most convenient to repair. You never have to break a pipe joint they are all on the body.



We know this Trap will please you. May we send you one for trial.

Reducing Valves, Exhaust Pipe Heads, Ejectors, Relief Valves, Separators, etc.

ESTABLISHED 1878
SEND FOR 1905 CATALOGUE

WATSON & McDANIEL CO.
147 N. Seventh Street, Phila. Pa.

REDUCING VALVES FOR ALL SERVICES

GUARANTEED TO GIVE ENTIRE SATISFACTION

MANUFACTURERS OF

Steam Traps for all services, Damper Regulators, Back Pressure and Relief Valves, Grease Extractors, Steam Separators, Hot Water Temperature Controllers, Boiler Feeders, Tank Pump Controllers, Float Valves, Water Arches, Waste Heat Utilizers, Pump Regulators, Automatic Receivers and Pump Regulators, Water Feeders, Combination Muffler Tanks, Grease Extractors, etc.

Write for Catalogue.

KIELEY & MUELLER
34 West 13th Street, NEW YORK CITY
JAMES J. BROGAN, 810 Race Street, Philadelphia, Pa.

WRITE FOR CATALOG "L"

THE "STERLING" EXHAUST HEAD for separating condensation from Exhaust Steam. Causes absolutely no back pressure. SENT ON TRIAL FREIGHT PREPAID. For sale by contractors and supply houses.

THE "STERLING" VENTILATOR allows free egress of the air and is weather proof. The most durable, and efficient stationary ventilator made.

THE "STERLING" REVOLVING VENTILATOR is efficient, reliable and requires no power or attention, insures a high degree of ventilation.

The Sterling Blower and Pipe Mfg. Co., HARTFORD, CONN. N. Y. OFFICE:— 136 Liberty Street.

Goetze's

Elastic Copper Gaskets

For High Pressure Steam, Air Pressure and Superheat

It will pay you to investigate.
Send for a testing sample.
Holds where others fail.

Frederick Goetze, 725 E. 141st St., **New York**

ZENA

BEST HIGH-GRADE HIGH-PRESSURE PACKING

The toughest, most elastic and most pliable packing made A few turns used in connection with any packing you now have will improve that packing greatly.

Try it and you will always be a friend of Zena.

WRITE TO ME AND ASK ABOUT IT

RANDOLPH BRANDT, 70 Cortlandt St., New York

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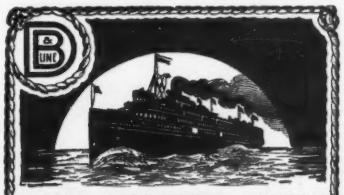
To solicit subscriptions for The Practical Engineer



THE WATER WAY
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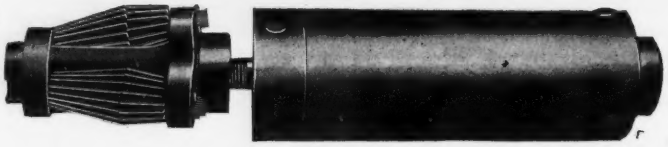

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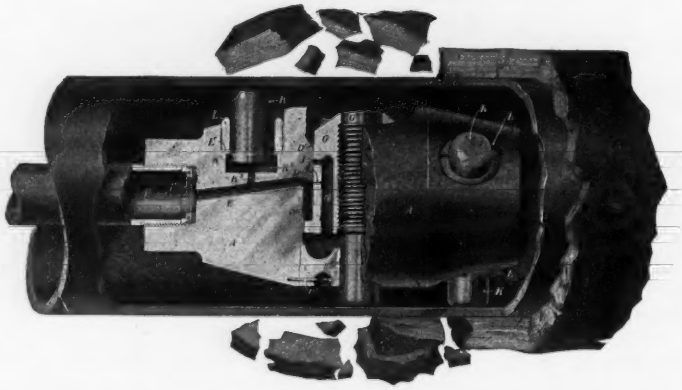

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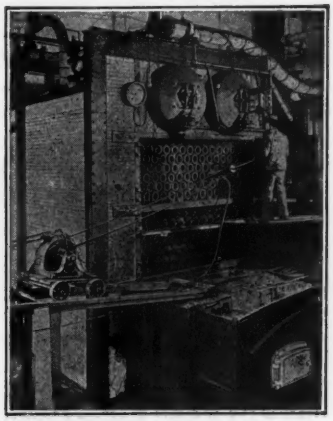

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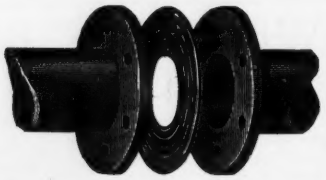

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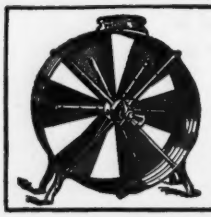

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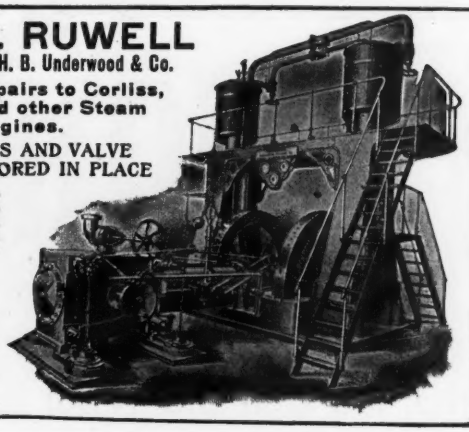

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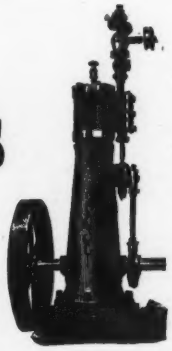

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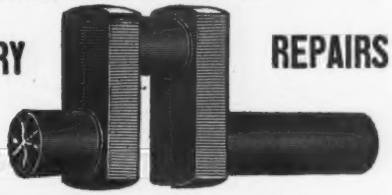

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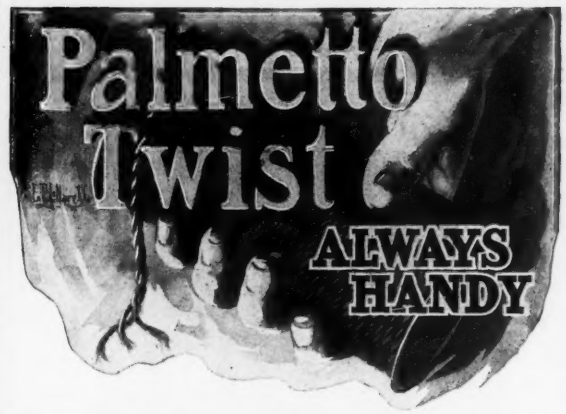

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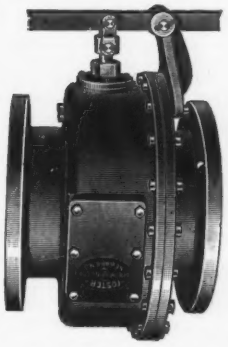

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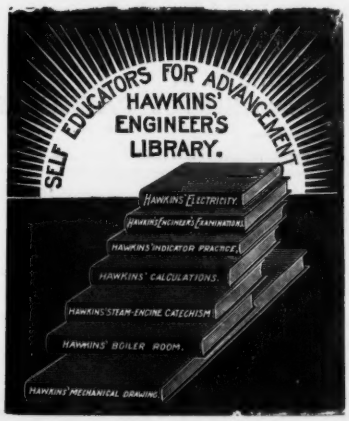

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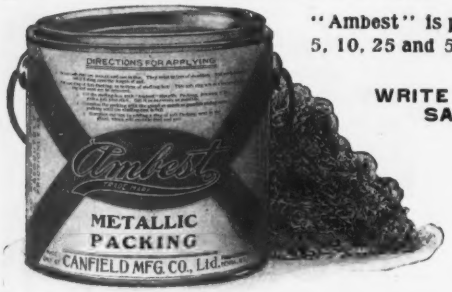

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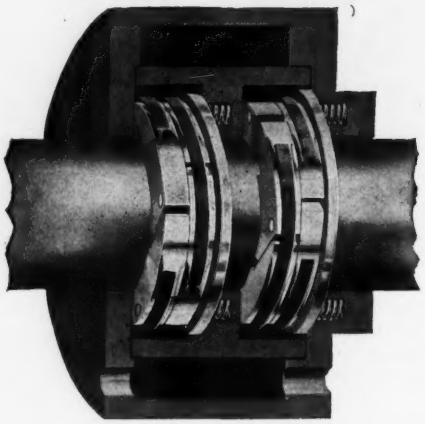

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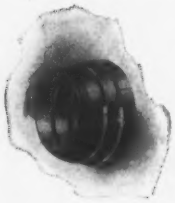

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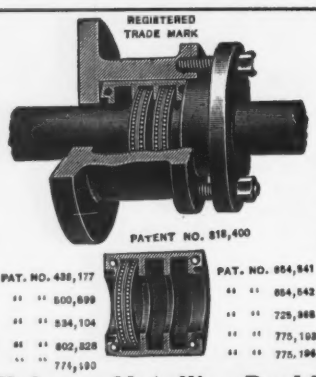

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142 N. 6th St., Phila., Pa.
Frick Bldg. Pittsburg, Pa.
160 Lake St., Chicago, Ill.
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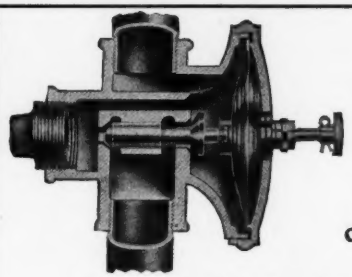


No Wire Drawing

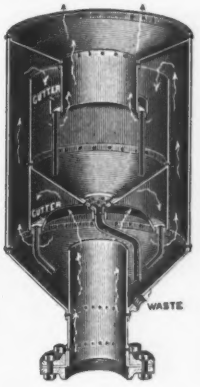
WITH THE

DUNHAM STEAM TRAPS

Our Proof — Thousands of satisfied customers.

Send in your trial order today and be convinced.

C. A. DUNHAM COMPANY
MARSHALLTOWN, IOWA
Resident Manager, L. BANCROFT MELLOR
No. 14 S. Fourth Street, Philadelphia, Pa.



THE WRIGHT
"Cyclone" Exhaust Head
For the Care of Your Roof

WHEN the question of buying an Exhaust Head arises remember — Experience is the best proof as to Reliability—Ask one of your neighbors about the "Cyclone". Some body near you has one—They are in use every where—Sold subject to Guarantee.

WRITE FOR ILLUSTRATED CATALOG

WRIGHT MANUFACTURING CO.
72 Woodbridge St., Detroit, Mich.

What's *the* Difference?

30-Days Trial will prove that Lindstrom's Liberating Valve *Steam Trap* is a wonder. *The only Successful Steam Trap.* It takes care of itself.—No parts to get out of order.—The Valve never leaves the Seat.—No scale can get between Seat and Valve. The Lid is ground, no packing needed

WARSAW GAS AND ELECTRIC COMPANY

Warsaw, N. Y., July 9th, 1906

Mr. JOHN T. LINDSTROM, M. E.,
214-216 S. 3rd. Street,
Allentown, Pa.

Dear Sir :—

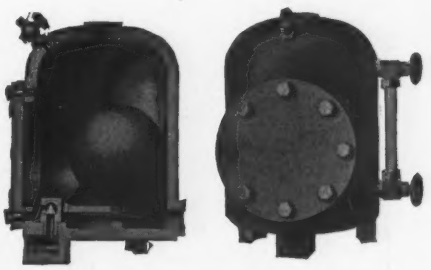
Mr. J. T. Lindstrom has jast completed the repairs on our 18 in. x 42 in. Copper Corliss Engine, consisting of the reboring of the cylinder, also the valve pockets, and fitting the same with new bull and steam rings, new valves and valve stems, also bushing the bonnets which were badly worn, and making other repairs not mentioned in contract.

We are satisfied that the work has been done in a strictly first-class workmanlike manner, and at this time can see no reason why our engine is not as good as new.

Respectfully,
WARSAW GAS & ELECTRIC CO., W. E. Hemenway, Sup't.

Special Discount during the next 2 Months.

Send for New Catalogue L.



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John T. Lindstrom
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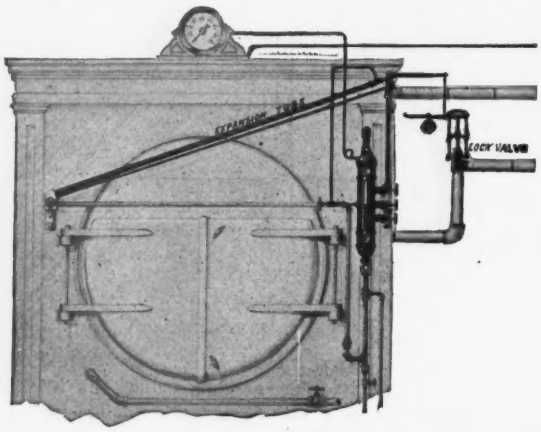
PHILADELPHIA AGENTS
American Boiler Economy Co.
420 MUTUAL LIFE BLDG., PHILADELPHIA, PA.

The Regulator That's Different

LET US TELL YOU WHY

The Copes Boiler Feed Regulator is different because its action is as positive as the rising and setting of the sun. It has no floats, springs diaphrams or concealed parts. It is actuated by a simple expansion tube, which has never once failed to do its duty in ten years of service under all sorts of conditions. No other regulator can show such an unbroken record of success.



Furnished on free trial that imposes no obligation to purchaser. Three years' guarantee.

Investigate our House Tank Regulator, our Elevator Tank Regulator and our Pump Governor

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AMERICAN BOILER ECONOMY CO., 420 Mutual Life Building, Philadelphia, Pa.

Successor to WILFONG & WILTBANK

AGENTS FOR NEW ENGLAND STATES,
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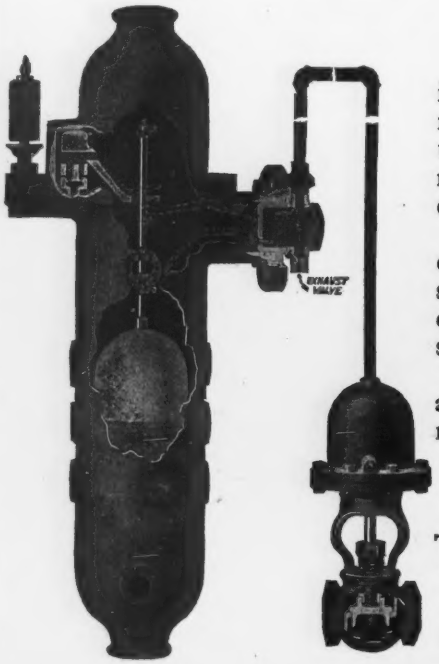
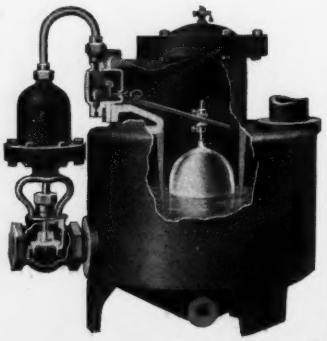
REPRESENTATIVE FOR MARYLAND AND DISTRICT OF COLUMBIA
John H. Walter, 1227 W. Lafayette Ave., Baltimore, Md.

THE WILLIAMS

Safety Feed Water Regulator



is an absolute necessity on every well regulated boiler plant. It maintains a uniform water level which permits of regular firing, insures dry steam, greater efficiency and less repairs.



Williams Steam Operated Trap

The Williams Steam Trap is different from others, its discharge is like a shot from a gun. There is no cutting or wire drawing because its full discharged capacity is instantly available.

The Williams Pump Governor will regulate the action of your pumps closer than any other governor made. Engineers are invited to investigate it.

Williams Pump Governor

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THE WILLIAMS GAUGE CO.

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DEARBORN LABORATORIES

Have introduced Chemistry in the scientific, correct and economical treatment of boiler waters. Gallon samples of the feed water are analyzed from time to time, and the treatment furnished constantly meets requirements in the prevention of scale, corrosion, foaming or such troubles as each particular water may produce.

DEARBORN TREATMENT will positively keep your boilers clean and well preserved.

DEARBORN TREATMENT is made on such lines that the quantity required to treat each thousand gallons of water is small, consequently its use is economical.

You are further assured that a house of chemical standing will use no materials that in themselves would be injurious to your boiler plant.

If you have not adopted Dearborn Water Treatment as thousands have done, send us gallon of water for analysis and proposition.

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WM. H. EDGAR, Founder

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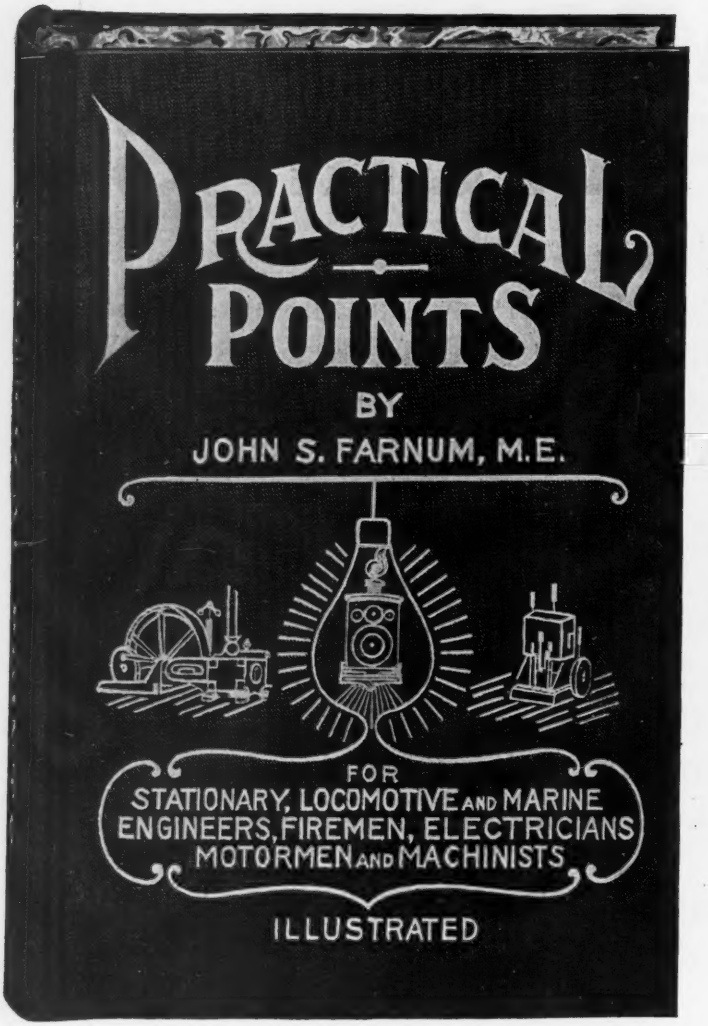


You never can tell what you CAN'T do until you try.

This book will tell you how to do things you can't do now.

You can have it FREE

CUT OUT a piece of scale from your boilers.
CUT OUT the coupon below and send it to us with the scale.

We will send you a Certificate of Analysis of the scale along with the book free of charge. We will also show you how you can get rid of scale by using

Lord's Boiler Compounds

GEO. W. LORD COMPANY
2238-50 N. 9th Street, PHILADELPHIA, PA.

To
Geo. W. Lord Co.
2238-50 N. 9th Street,
Philadelphia, Pa.

Gentlemen: I am sending you a sample of scale from our boiler. You are to analyze it, and send me, free of charge, a certificate of analysis and the book.

*Number of boilers in use*_____
*Capacity of each boiler*_____
*Frequency of cleaning boilers*_____
*Frequency of opening the blow-off during working hours*_____ *River or other source of water supply* _____
Boilers are used about _____ *hours out of 24*
*Coal burned per day*_____
Water evaporated per day _____
*Name*_____
*Street and Number*_____
*City*_____ *State*_____
Firm's Name _____
Date_____

P. Prac. Eng.

HAVE YOU SENT US A SAMPLE OF SCALE?

If so, You are Interested in This:

If you sent us the sample of scale you know that we sent you the small souvenir promised and a Certificate of Analysis of the scale. Then we wrote you giving information about our methods.

You are now ready for our next proposition This will interest you far more than our offer of a small present for the scale.

Cut out the coupon below and fill it up properly. Send it to us and we will mail you full particulars about our new offer.

This applies to every man who sent us a sample of scale since August 1st, 1905.

Geo. W. Lord Company

2238-50 North 9th Street

Philadelphia, Pa.

Geo. W. Lord Co.
2238-50 N. 9th St.
Philadelphia, Pa.

Gentlemen — Kindly send me, free of cost, your Special Proposition.

Name _____

Home Address _____

Certificate of Analysis No. _____

Firm's Name _____

Firm's Address _____

City _____ State _____

September _____

The Practical Engineer

Climax Lubricator

FORCE FEED

WITH SIGHT-FEED—Patented

RADICALLY differs from all others and LEADS all

IT IS MOST POSITIVE because it has a slow suction and quick stroke

IT IS MOST ACCESSIBLE because it has outside valves

IT WILL LAST YEARS

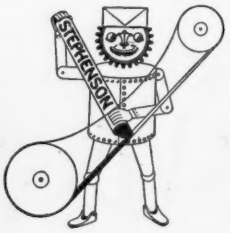
IT HAS A PERFECT SIGHT FEED

CATALOGUE will tell you why it is better than any other

Climax Lubricator Co.
3 Appleton St., Boston, Mass.

Philadelphia Representative
L. BANCROFT MELLOR
14 S. Fourth Street, Philadelphia

"FORCE-FEED is the only positive lubrication"



If we could Make a Better

Belt Dressing

than we now do it would still be

Stephenson

This registered Trade Mark on each pound stick your Protection

Did you ever test Stephenson?
May we send you a free sample?
RED Lable for Leather.
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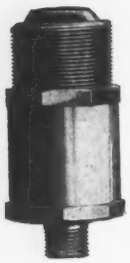
Stephenson Mfg. Co.
ALBANY, N. Y.

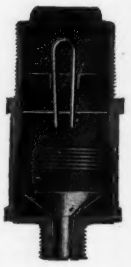
The "PHILADELPHIA" GREASE CUP

Automatic application of grease to the bearings without the use of spring compression.

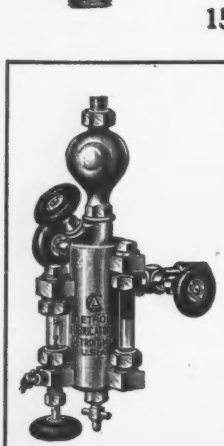


Nature supplies the Feeding Force in the Form of Compressed Air.

With many thousands of our grease cups in successful operation, we are in position to offer a system of lubrication for all ordinary machinery bearings which, for simplicity, cleanliness, economy, reliability and efficiency has no equal. Don't forget that we guarantee an actual saving of at least 50 per cent over any other system in use.



The Philadelphia Lubricator & Mfg. Co., Inc.
1525 Land Title Building, - - Philadelphia, Pa.



The Detroit Lubricators

Are Standard the world over.

More than 850,000 of them are in use.

Look for the GENUINE ORIGINAL PACKAGE. Catalogue on Application.

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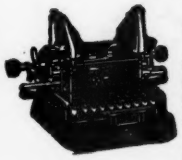
DETROIT, MICH.

YOU CAN EASILY OPERATE THIS TYPEWRITER YOURSELF



Don't worry your correspondent.

Don't write him anything by hand that akes him time to make out—that may leave him in doubt—that he can't easily read.

And don't fil out ega. papers or card memos—or make out accounts in your own handwriting.

It looks bad, reflects on your standing, makes people think you can't afford a stenographer, and is sometimes ambiguous.

You can write out your letters—make out an abstract—fill in an insurance policy—enter your card memos—make out your accounts, or a hotel menu—or do any kind of writing you need, on any kind, size or thickness of paper and space any way you wan on

The OLIVER Typewriter

The Standard Visible Writer

You can write any of these things yourself if you do not happen to have a stenographer.

For you can easily learn with a little practice, to write just as rapidly and as perfectly, as an expert operator on the OLIVER. Because the OLIVER is the simplified typewriter. And you can see every word you write. About 80 per cent. more durable than any other typewriter, because it has about 80 per cent. less wearing points than most other typewriters.

Eighty per cent. easier to write with than these other complicated, intricate machines that require "humoring"—technical knowledge—long practice and special skill to operate.

Than machines which cannot be adjusted to any special space—with which it is impossible to write abstracts, insurance policies, or odd-size documents except you buy expensive special attachments requiring experts to operate.

You can adjust the OLIVER to any reasonable space—you can write on any reasonable size and thickness of paper, right out to the very edge, without the aid of any expensive attachment or special skill, and your work will be neat appearing, legible and clear

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Write us now for our booklet on the simplified features of the OLIVER.

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BOILER DOOR ARCHES AND FIRE BOX BLOCKS

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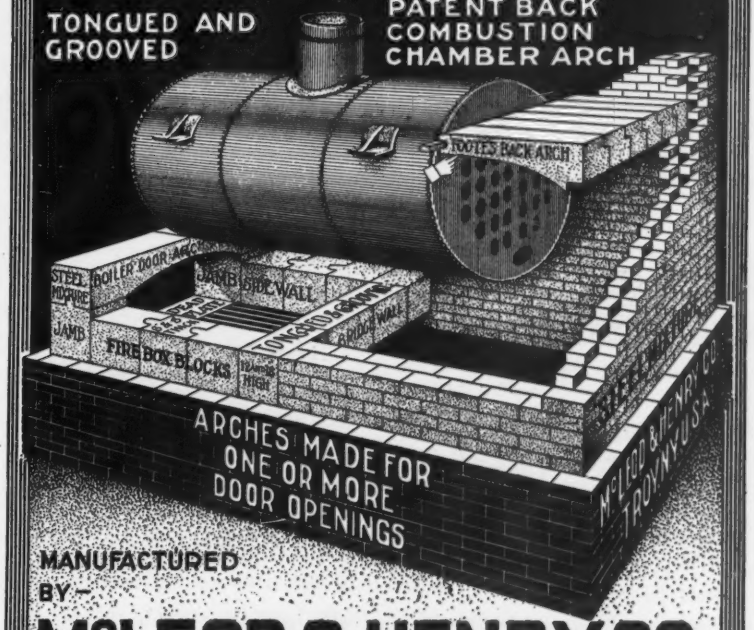
PATENT BACK COMBUSTION CHAMBER ARCH



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A—Fibrous Packing. B—Metal.
C—Open space to avoid butting when cover is worn off
D—Section of metal cut out at C.

Adapted to all kinds of Steam and Water Packing. Will not cut Rods, will not wear rods to shoulder, will not harden under compression. More durable than fibrous packing. Less friction, as it is lubricant of itself. For packing engines, steam hammers, cranes, valves, expansion joints, pumps, elevators, accumulators, hot-water plunger pumps, etc. **Cotton, Linen and Square Flax Packing in Stock.**

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Walsh Combination Gaskets

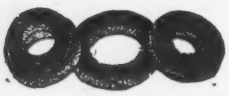
WILL NOT BLOW OUT

Can be used from 10 to 40 times.
The Cheapest Gasket Made.

A—Soft Metal. BB—Rainbow Rubber. Composed of Soft Metal and Rainbow Rubber as shown in cut. Made different widths and thicknesses for man and hand hole Gaskets

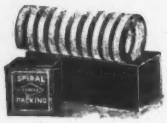
Packings

Eureka Gum Core

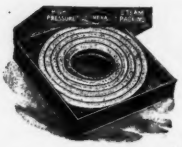


Eureka Ring

Eureka Ammonia



Eureka Spiral



Eureka High Pressure

Eureka Sheet

WE would like to nail to the mast every assertion we make regarding the worthy of our 8 kinds of EUREKA PACKINGS.

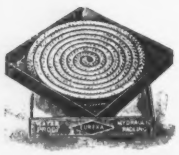
It has taken us over a quarter of a century to place the name "EUREKA" where it is in the estimation of the Steam Engineering World, and we cannot afford to make a false statement or create a wrong impression about our 8 kinds of EUREKA PACKINGS.

No better packings are made for the purpose for which each is intended. No packings are more reasonable in price,—none will give better service. Quality of raw material is our first consideration, close attention to detail of manufacture our next, and continuous improvement wherever possible, our constant endeavor.

If you want a sample of our 8 kinds of EUREKA PACKINGS ask your dealer or write direct to us.

EUREKA PACKING CO., Sales Dept.
JAS. L. ROBERTSON, President.

Eureka Square Flax



Eureka Water Proof

It will pay you to get our low cash prices or very easy terms on Robertson Thompson Indicators, Willis Planimeters, and Victor Reducing Wheels.

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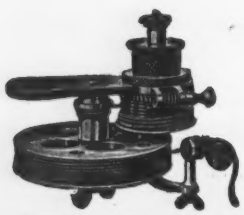
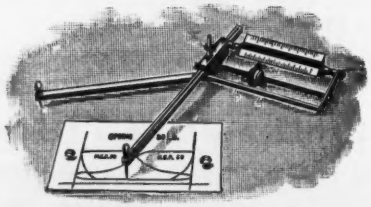
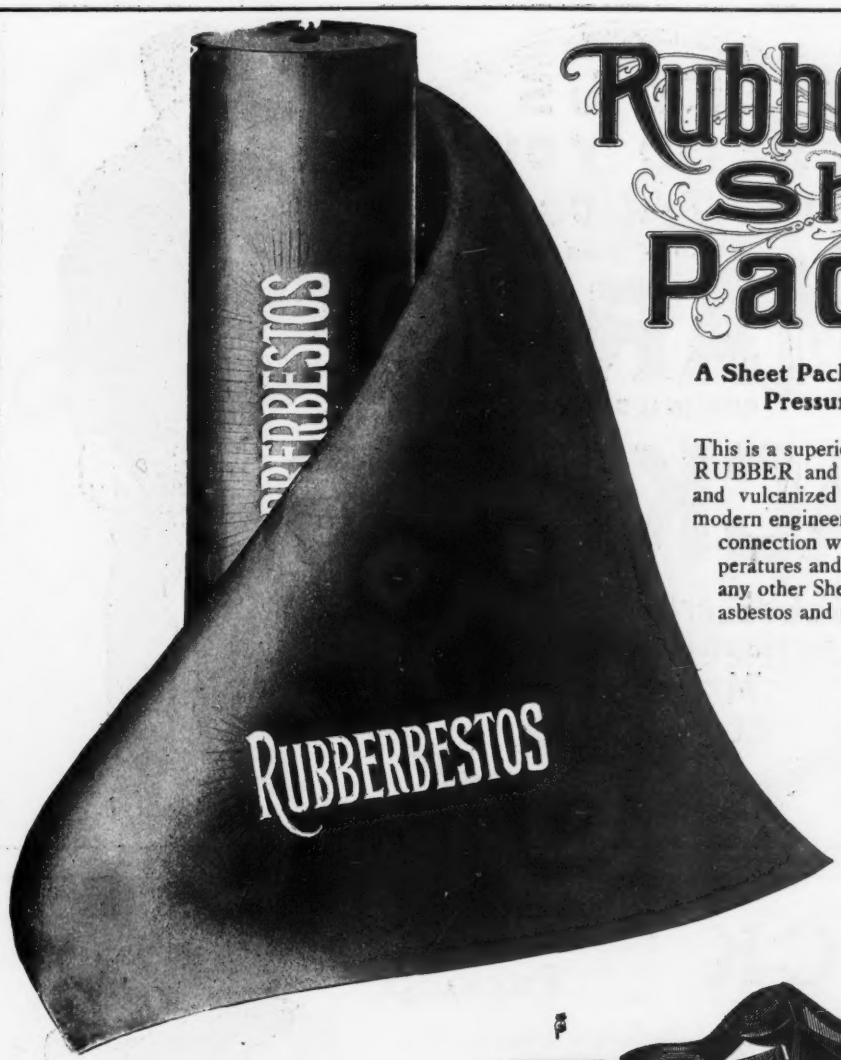


A Victor Reducing Wheel



The Willis Improved Planimeter

Robertson-Thompson Indicator



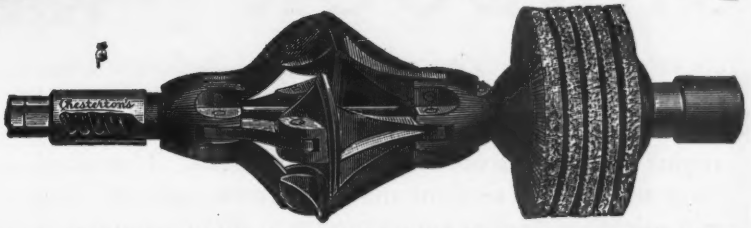
Rubberbestos Sheet Packing

A Sheet Packing of Highest Quality for High Pressures and High Temperatures

This is a superior quality of Sheet Packing made of fine RUBBER and ASBESTOS scientifically compounded and vulcanized to meet the highest requirements of modern engineering practice. It is intended for use in connection with very high pressures and high temperatures and will last three or four times as long as any other Sheet. It is our way of combining the asbestos and rubber that gives it such great heat and pressure resisting qualities. No better packing can be made. It is also made with **metal insertion** for **rough** or **uneven** flanges and with **wire insertion** for **extreme pressures**

Combination Flue Scraper *and* Brush

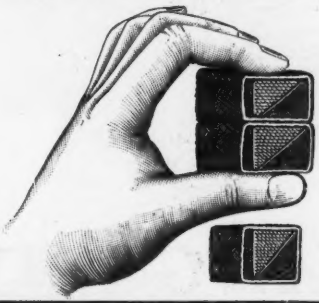
The advantage of this Cleaner is that it renders **Double Service**, **scrapes** the flues and **brushes** them **like new** all in **one operation.** Another



feature is that the **spring** is **protected** from the **heat** and **dirt** and the **chilled** scraping edges are **more durable** than steel. The spring is easily adjusted to any tension desired. The tool cost but a trifle and **it pays for itself** every time it is used. You cannot afford to put off getting one. No, not even for a day.

"Combination" Packing

will hold your rods steam tight with no more pressure on the gland than can be exerted with the fingers. Pure soft flax in contact with the rod which acts as a reservoir for oil insuring perfect lubrication, and a Pure Rubber Back to maintain life and expansion to the last.



RUBBERBESTOS SECTIONAL GASKETS

These Gaskets are made of Rubberbestos with a fine wire mesh or metal centre which leaves them pliable and easily manipulated yet with wonderful pressure resisting qualities. Gaskets of any size can be made in a few minutes.

A. W. CHESTERTON & CO.

No. 64 India St., BOSTON, MASS., U. S. A. or

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THE CLEVELAND RUBBER WORKS
OF THE MECHANICAL RUBBER CO.
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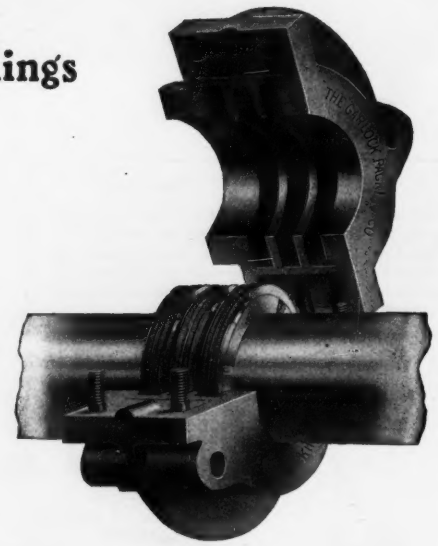
GARLOCK Metallic-Packings

are superior to any other make of Metal Packings. They are made with a heavy split case of superior design and construction so that they can be quickly applied to any engine without disconnecting the crosshead. The metal rings are made in sections and are so arranged that they will adjust themselves automatically to slight variations in the rod and will take up for wear, holding perfectly steam tight at all times with the slighest possible pressure on the rod. Don't order metallic packing until you get our new booklet.

FOR THE MOST COMPLETE LINE OF FIBROUS PACKINGS IN THE WORLD ASK FOR A LARGE GENERAL CATALOG



The GARLOCK PACKING CO.

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Lest you forget

we want to keep on reminding you about the superior points of the

"SWARTWOUT"

Cast Iron Exhaust Head

We want to show you how you will add each year to your

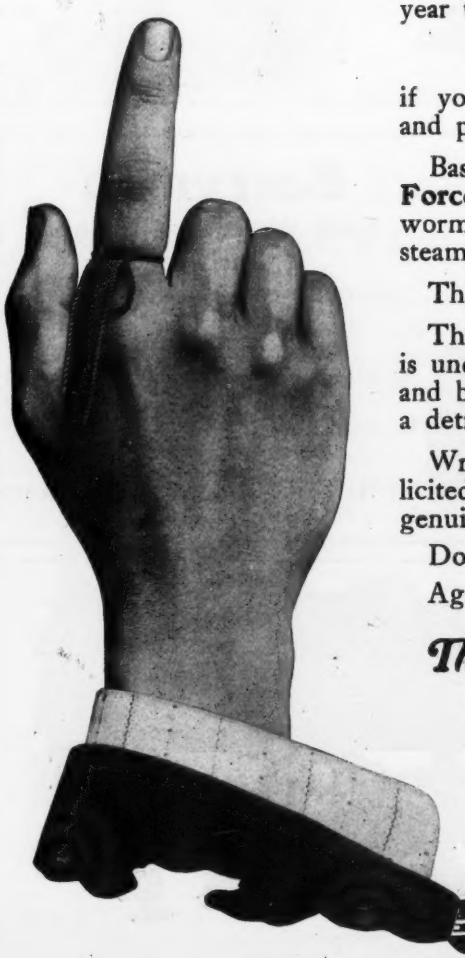
Profit and Loss Account

if you install one of these everlasting, practicable and profitable Exhaust Heads.

Based on the scientific principle of **Centrifugal Force** the steam is whirled around through the helical worm so that all the moisture is kept in while the steam slowly departs through the Exhaust.

This makes it pleasant, clean and profitable.

Then, being made of **all cast iron,** its durability is unquestioned—it lasts a life time—needs no repair and being very compact it's an ornament, rather than a detriment, to any factory.



Write for prices—also get the unsolicited testimonials of users as to their genuine worth.

Do so today.

Agencies in all principal cities.

***The* Ohio Blower Co.**

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There Are Reasons For It.

The Patterson-Berryman Feed Water Heater and Purifier

AND

The Patterson Belt Pump

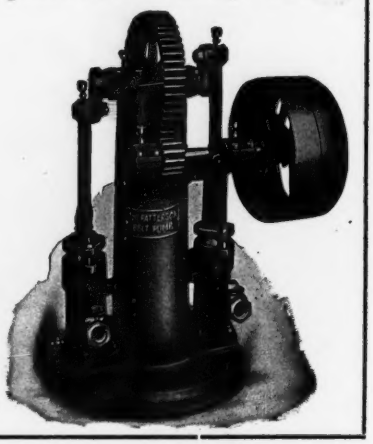
are sold on trial with the distinct understanding that they may be returned to us at our expense should either prove unsatisfactory. *Because*

They are manufactured of the best material and workmanship.

Their efficiency and durability is the highest.

They are simple in construction reducing repairs to the minimum.

If you are interested we would like to explain whys and wherefores.



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The Baum Separator

Horizontal Style for live Steam or Oil Service.

For Live and Exhaust Steam
RESULTS GUARANTEED

Repeat orders are the best evidence of satisfactory results on the part of a satisfied customer.

"We are using the second Baum Separator and are very much pleased with the results we are getting from it," writes one who has been using Baum Separators for several years.

Write for further information before placing order. A new catalog on request.

Vacuum Style Oil Extractor.

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Berryman

Feed Water Heaters and Purifiers

WATER TUBE AND STEAM TUBE

Cast Iron or Steel Shells. "U" Shaped Seamless Drawn Brass Tubes.

We Build Heaters for every Purpose and Condition

THE KELLEY PATENT
Improved Berryman Water Tube, Feed Water Heater and Purifier

BENJ. F. KELLEY & SON, Makers
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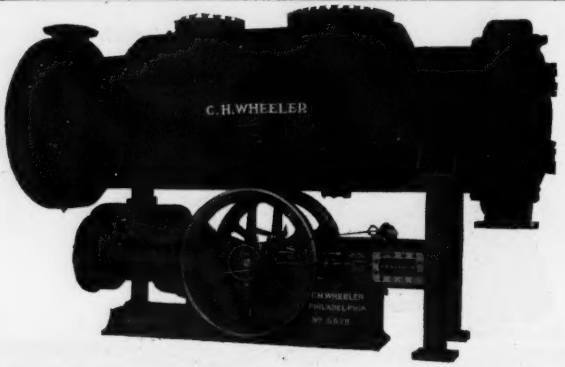
HIGH VACUUM APPARATUS

SUCTION VALVELESS AIR PUMPS
Vertical and Horizontal Designs

WATER COOLING TOWERS
FEED WATER HEATERS



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NEW YORK CHICAGO PITTSBURG CLEVELAND ST. PAUL SAN FRANCISCO

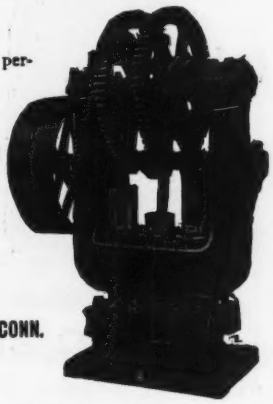
The Gleaner

The **Gleaner** represents the acme of perfection in feed water heating.

THE

Davis Triplex Power Pump

is a perfect type of the vertical triplex belt driven pump.



MANUFACTURERS OF
The "Berryman" Feed Water Heater and Purifier.

I. B. DAVIS & SON, HARTFORD, CONN.

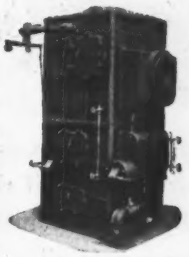
WRITE FOR CATALOGUE, ETC., TO

THOS. McADOO, 125 N. 4th St., Philadelphia

Want to Get Rid of Scale?
Need More Steam?
Want to Cut Down Coal Bills?

A Cochrane Heater will fix you up.

In one plant where we recently installed a Cochrane Heater, they opened the Heater after a 21-hour run and found on the bottom a quarter-inch deposit of scale-forming impurities which the Heater had taken out of the feed water.

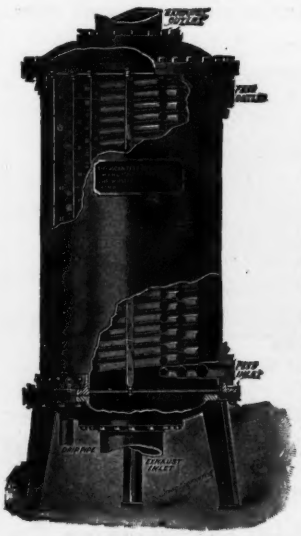


This Heater is now keeping their boilers free from scale. It has eliminated trouble from leaky and burnt tubes, and they can get the same steam with 15 per cent less coal, or get 15 per cent more steam with the same coal, because of the hot water from the Heater which they feed to their boilers and because of freedom from scale.

Maybe **you** are troubled with scale and have to burn too much coal, or force your boilers in order to get enough steam. We would like to talk Heaters with **you**

HARRISON SAFETY BOILER WORKS,
3144 N. 17th Street, Philadelphia, Pa.

The American Standard Copper Coil Feed Water Heater



Simplicity!
Strength!
Economy!
A Money Saver!

It gives so little trouble that one of our customers, who has used one for three years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

THAT.S THE KIND OF A HEATER YOU WANT.

Write for Catalogue No. 100 P

The Whitlock Coil Pipe Co.

HARTFORD CONNECTICUT

YOUR Declaration of Independence

Everybody knows what the stroke of a pen did for this great nation.

Do you realize what the stroke of a pen or pencil will do for you?

The coupon shown below is the wage earners' declaration of independence. Signed and sent to the I. C. S., it brings, without further obligation to you, practical advice and explanation of how that wonderful institution, the INTERNATIONAL CORRESPONDENCE SCHOOLS, that have enabled 100,000 men and women to advance from low-waged jobs to high-salaried positions, can help **YOU** to better your position and increase your earnings without losing an hour of work or a dollar of pay, or paying more than your present income will afford, no matter how small it is. We fit our plan to your own individual case and needs in a way that makes success for you certain. Do you wish for freedom from overwork and underpay? **Then sign your Declaration of Independence and mail it today.**

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Box 835, Scranton, Pa.

Please explain, without further obligation on my part, how I can qualify for a larger salary in the position before which I have marked X.

Mechanical Engineer	Marine Engineer
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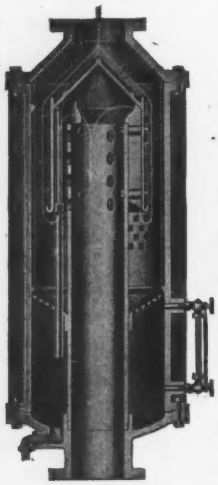
Chemist	Architect
Sheet-Metal Draft's	Bookkeeper
Electrician	Stenographer
Stationary Engineer	Ad Writer

Name _____

St. & No. _____

City _____ *State* _____



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When considering the Separator subject, please let us send our catalog and blue prints; look up the dimensions, weights and proved efficiencies of our machine, compare them with others and see if we don't furnish the most for the money; then consider the **plan** and **finish** of our separators; see if the plan is such that **you think** it will give the results claimed. Made in all styles, for steam or oil.

SEND FOR CATALOG. ALL STYLES.

Direct Separator Co.

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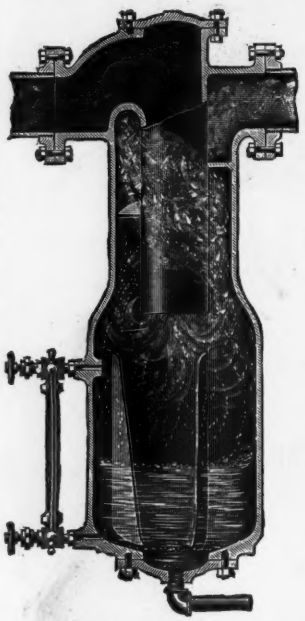
THE BENJAMIN F. SHAW COMPAN , Wilmington, Del.

THE STRATTON

Steam Separator



Will deliver **Dry Steam** to your engine under any and all conditions, no matter how long your steam pipe or how much your boilers may prime.

Separation takes place by the action of centrifugal force imparted to the steam. The large capacity not only provides for a sudden influx of water but forms a reservoir of steam which equalizes the pressure between boiler and engine, thereby increases the power and stops the vibration of steam pipes; a separator of small capacity is worse than useless, it is harmful.

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Four massive volumes. Over 3,000 pages—size of pages, 7 x 10 inches. Bound in three-quarters red morocco. 2,000 engravings. Especially designed for the machinist, tool maker, pattern maker, sheet metal worker, draftsman, steam and gas engine engineer, electrician, etc., who has not the time to take a regular course of instruction or who cannot afford it.

Regular Price, $24.00

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Let us send you the entire set, express prepaid for five days' free examination. Pay us $2 down and $2 a month for nine months if you keep the books. Cash price, $10.80. We send for them at our expense if not satisfactory.

The only reason we make such a liberal offer is to interest the public in the extraordinary advantages offered by the regular courses of the American School. A 200-page hand-book sent free on request.

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Machine Shop Work, Tool Making; Pattern Making, Machine Design, Metallurgy: Gas and Oil Engines, Producer Plants, Automobiles, Elevators, Steam Engine, Steam Turbine, Management of Dynamos and Motors, Forging, Sheet Metal Work, Tinsmithing, Mechanical Drawing, Mechanism.

American School of Correspondence

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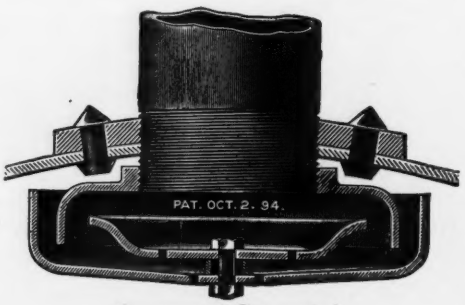
THERE ARE MORE

Compound Separators

used in boilers than all others.

They insure dry steam, and protect your engine from water.



Compound Separator

Boiler Fronts, Grate Bars, Furnace Castings, Compound Separators, and General Boiler Castings

The Kutztown Foundry and Machine Co.

WORKS:

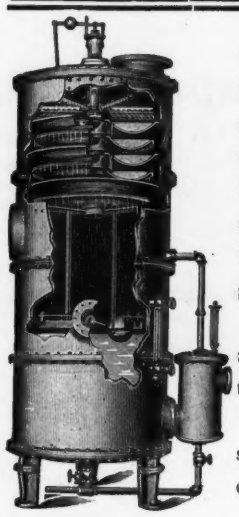
KUTZTOWN, PENNA.

Philadelphia Office: Fidelity Building, Broad above Arch Street.

A Heater That Will Save Its Cost In a Short Time

There is one heater that will do this—that's the

Pittsburgh Feed Water Heater and Purifier



Through its use, your power is increased, your coal bills are decreased. We can cite plenty of evidence to support this statement. No matter what kind of a heating system you are now using, if it isn't the "Pittsburgh" you are not getting the best possible results.

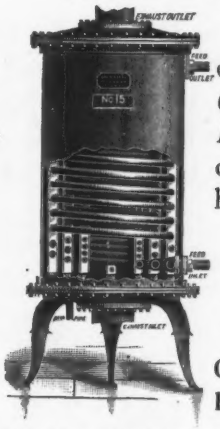
Why not install the "Pittsburgh," a heater that is GUARANTEED to do its work thoroughly.

We would like to talk over the subject with you. Let us forward our Catalogue and prices.

James Bonar & Co., Inc.
716 Frick Building Pittsburgh, Pa.

The National Feed-Water Heater

2,500,000 Horse Power in Daily Use



The principal characteristics of these heaters are *Simplicity, Cheapness, Reliability and Effectiveness,* and full amount of heating surface in every heater.

Supplies Water to the Boiler at 212° F.

We manufacture the Original and Only Genuine First-Class Coil Feed-Water Heaters.

We Also Manufacture All Kinds of Coils in Iron, Brass and Copper Pipe

Catalogue and Prices on Application.
Manufactured and Sold Only by

THE NATIONAL PIPE-BENDING CO.
157 Lloyd St. NEW HAVEN CONN.

THE GEMMEL PATENT BOILER

JAMES GEMMEL
Phones:—Bell, Market, 11-73 D Keystone, Main, 46-91 D

This Vertical Boiler possesses all the advantages of a Horizontal Boiler and none of its expensive disadvantages.

It requires only small floor space. It requires no expensive setting. It affords a natural path for the flue gases, and is a rapid steamer.

Its improved construction guarantees rapid circulation, and the highest degree of efficiency.

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ENGINEERS. BOILER MAKERS.
MACHINE BLACKSMITHING.

Machinery Repairs—Cylinders of Engines and Pumps Rebored in place. Stacks, Tanks and all kinds of Boiler Work.

ELEVATOR REPAIRS

YOU HAVE ELEVATOR TROUBLES. WE HAVE EXPERIENCE. LET'S SWAP.

Keystone Elevator Inspection & Repair Co.

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We furnish these fittings complete, including all drilling facing etc.

BIRDSBORO STEEL FOUNDRY AND MACHINE CO.

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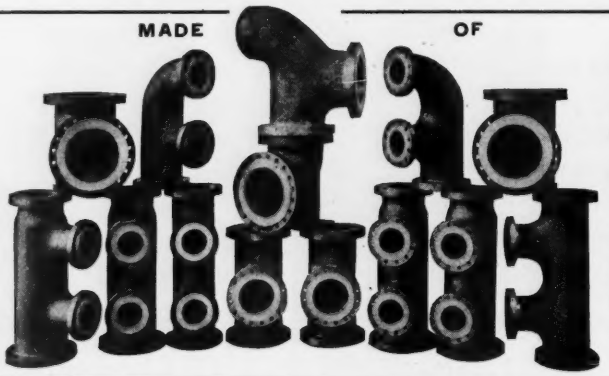

O. H. Steel Castings

All castings tested to 1000 lbs. hydraulic pressure if desired.

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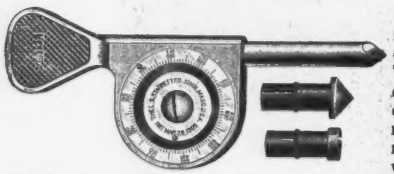
Speed Indicator No. 104

Price, Postpaid, $1.00



This Indicator may be run at highest speed required, without heating. The working parts are encased. Dial has two rows of figures, reading either right or left as shaft may run. Steel pointed spindle with rubber tips for both pointed and centered shafts. The O mark may be instantly set at the starting point.

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and steadily advancing values in the shares of this corporation is the result of the methods employed in conducting the business.

Shares selling now $1.25 each (par value $1.00).

Send for Booklet. You will be interested.

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whenever you require a new throttling or controlling Valve just give the

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a trial and you will be convinced of its superiority. The Valve has a full open way through the body. To open or close the Valve simply move the lever back and forth. Are confident you will find the " TITAN " just the valve for the purpose It handles steam and other fluids most satisfactory.

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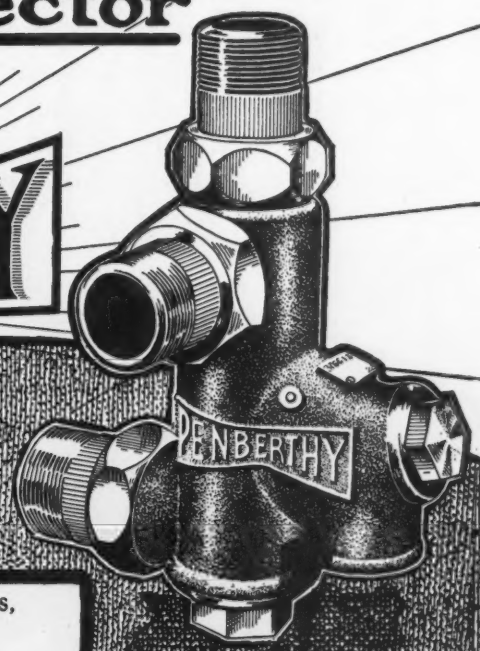
The Sun Never Sets on the Penberthy Injector

TRADE PENBERTHY MARK



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IN THE MIND OF "UNCLE SAM"

the U. S. Automatic is the World's best injector. It is officially endorsed by the U. S. Government because of superior merit.

The **U. S. Automatic** feeds hotter water than any other injector and works equally well as a lifting or non-lifting injector Never freezes, easily cleaned and always reliable. Saves fuel water and worry—100 per cent efficiency.

Each one is tested before leaving factory and actual results shown on the Certificate of Range and Capacity attached to it. Business prudence demands that you buy the U. S. Automatic.

FREE. Let us send you a copy of our famous **"Engineer's Red Book"**—free on request.

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Strong Reliable Durable

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AUTOMATIC INJECTORS are especially designed for severe service. The United States Government uses them on the Panama Canal, because they are reliable under the severest of conditions and give universal satisfaction.

You should know more about the CHICAGO. Send for our free catalogue of Injectors, Ejectors, Lubricators, High Grade Steam Specialties and Oiling Devices.

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Largest Manufacturers of Injectors in the United States.

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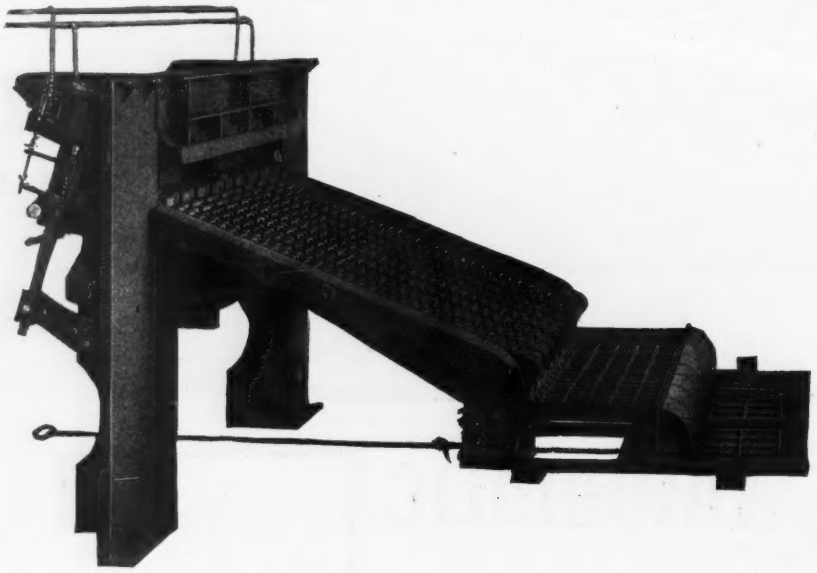
THE Cold Air that strikes your boiler when the fire doors are open, decreases your evaporation and causes constant contraction and expansion which will in time destroy any boiler, and may result in a disastrous explosion, to say nothing of the fuel thus wasted.

Irregular hand firiing is hard on the fuel pile, hard on the boiler and hard on the firemen. It is out of date and extravagant to a degree seldom realized by the man who pays for it all.



Wilkinson Automatic Stokers

are different. You don't have to open fire doors. You don't have to buy fuel to compensate for the heat thus lost. You don't have to pay repair bills because of the damage thus done. Your firemen don't have to stand before a seething furnace and stoke until they are ready to drop from exhaustion, for the WILKINSON feeds the coal constantly, regularly and always in small quantities as required. It saves its cost in a short time and elminates every particle of black smoke.

WILKINSON MANUFACTURING CO.

BRIDGEPORT, MONTGOMERY COUNTY, PA.

New England Roller Grate

NEARLY 6000 SETS IN NEW ENGLAND ALONE

THIS GRATE will burn any kind of coal and all of it. It has more air space than any other grate and is the only grate that does not change its opening when you shake it. It rests onrollers : is easy to shake : removes the ashes without disturbing the surface and does not drop coal into ash pit.

Made in all sizes, for all types of boilers and is easily installed without changing fire box or cutting away of boiler front. It costs practically nothing for repairs and it must and does save fuel.

CATALOGUE FOR THE ASKING

also Shaking, Dumping and a new type of stationary grates

New England Roller Grate Co., 310 Main St. Springfield, Mas

J. B. HACKETT, Temple Court Building, New York.
AMERICAN BOILER FLUE CLEANER CO., Mutual Life Building, Phila., Pa.

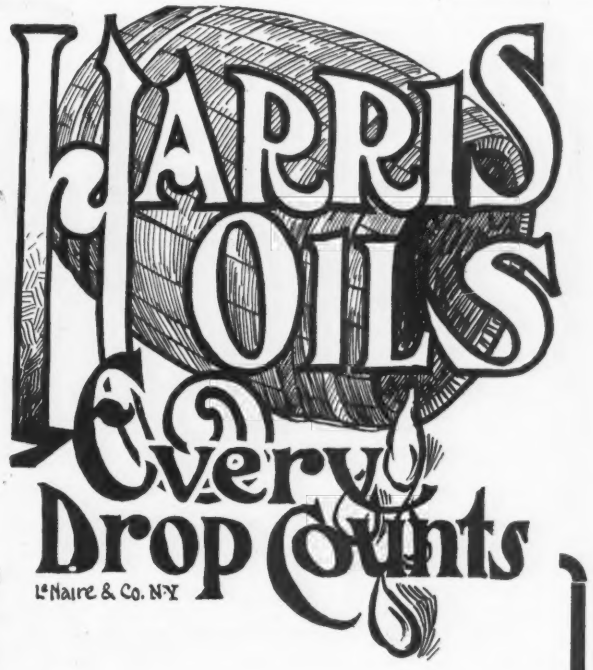
GET ONE FREE

Put it on your boiler, and give it a good trial for a month; if it gives you absolute satisfaction, keep it, and pay for it, otherwise send it back at our expense.

"P. B. H." WEIGHT GAUGE COCK

There is but ONE renewable part; the special metal valve pencil, which lasts for years and can be replaced for a few cents, in a minutes time. Thousands in use. Absolute satisfaction on high pressures.

THE PAUL B. HUYETTE CO., Inc. 1245 BETZ BUILDING PHILADELPHIA



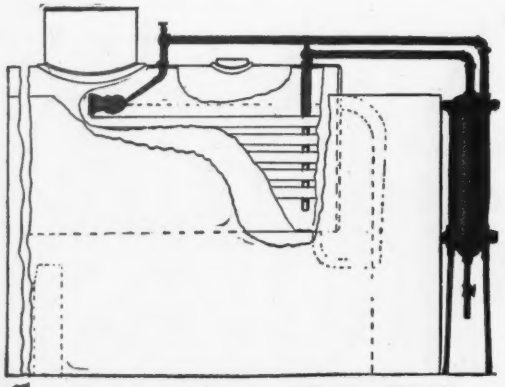
Every drop counts, in the way of better lubrication, in easing up the engine, in reducing the co-efficient of friction for unit of fuel used, because HARRIS OILS are specifically prepared to meet the conditions, which arise every day in the steam plant.

Engineers who are well qualified to know, will tell you that HARRIS VALVE OIL for internal use of the engine and HARRIS ENGINE OIL for external use can not be equalled.

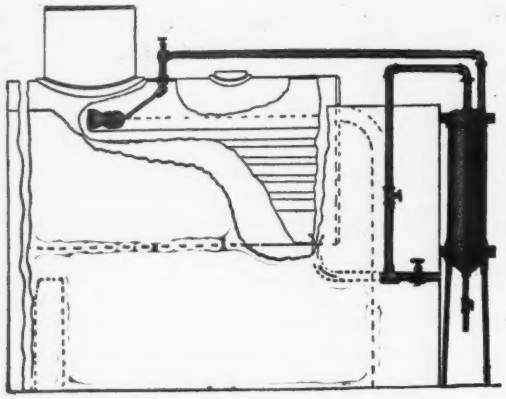
Why not write to us and tell us your engine trouble and hear the proposition we are now making? Send for our Catalog.

A. W. HARRIS OIL CO.

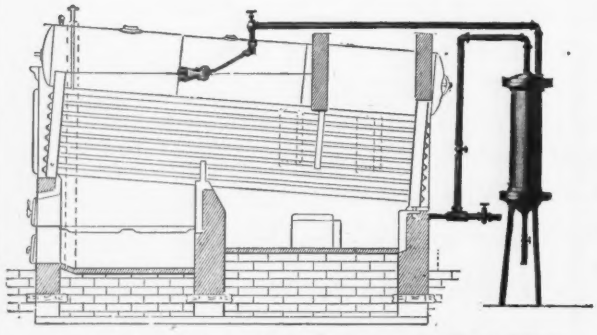
320 South Water Street,
PROVIDENCE, R. I.



SHOWING INSTALLATION RETURING THROUGH TOP OF BOILER



SHOWING INSTALLATION RETURNING THROUGH BLOWN OFF PIPE



SHOWING INSTALLATION AS APPLIED TO WATER-TUBE BOILERS

WHAT IT IS
WHAT IT DOES
AND HOW IT DOES IT

THE BUCKEYE AUTOMATIC BOILER is an appliance designed on the best scientific principles for the purpose of removing impurities from the water in steam boilers while they are under pressure and it does it.

All of the impurities come to the top at some period while the water is boiling. These impurities are collected by the Floating Skimmer and carried into the precipitator from which the pure water is returned to the boiler, still hot.

This action removes all the mud and scale forming matter all the time and keeps the boilers clean from one years end to the next without one cent of expense for boiler compounds; and a clean boiler is a money and trouble saver.

The Buckeye Skimmer is the only boiler cleaning device with a **Floating Skimmer** and is the only one that will give satisfaction on water tube boilers as the constant rise and fall of water renders the old stationary skimmers useless while the Buckeye follows the water level whether its high or low and is always working to its full capacity.

Hundreds of them in use and every user pleased.

We install them on trial and guarantee absolute satisfaction or no pay. After a trial you will not permit us to remove them.

Our large new catalogue tells the whole story. Write for it.

THE FLOATING SKIMMER

BUCKEYE BOILER SKIMMER CO.

COLBURN AVENUE, TOLEDO, OHIO

Works like Magic

Keystone Grease

THE ENGINEER who knows the full value of KEYSTONE GREASE as a lubricant, is the one who has time and time again been troubled with a bearing that would run hot in spite of every kind of oil or lubricant he could try, until as a last resort, he turned to KEYSTONE GREASE.

No bearing is too heavy to apply KEYSTONE GREASE. None too light; no temperature is too high, none too low.

One pound will lubricate better and last longer than 3 to 4 pounds of any other grease or 4 to 6 gallons of high grade oil.

We send FREE (no charge now or afterward to any engineer, A Large Size Sample Can of KEYSTONE GREASE, a Heavy Brass Grease Cup, and an Engineer's Cap. All we ask is name and business address, H. P. of engine, on what bearing sample will be tested, width of bearing on which sample will be tested, R. P. M. of crank pin, size of tap for cup.

KEYSTONE LUBRICATING CO.

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30 Oliver Street, Boston, Mass.

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C. A. DENNISTON, Mgr. Western Branch
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R. D. JACKON, JR., New York Agent,
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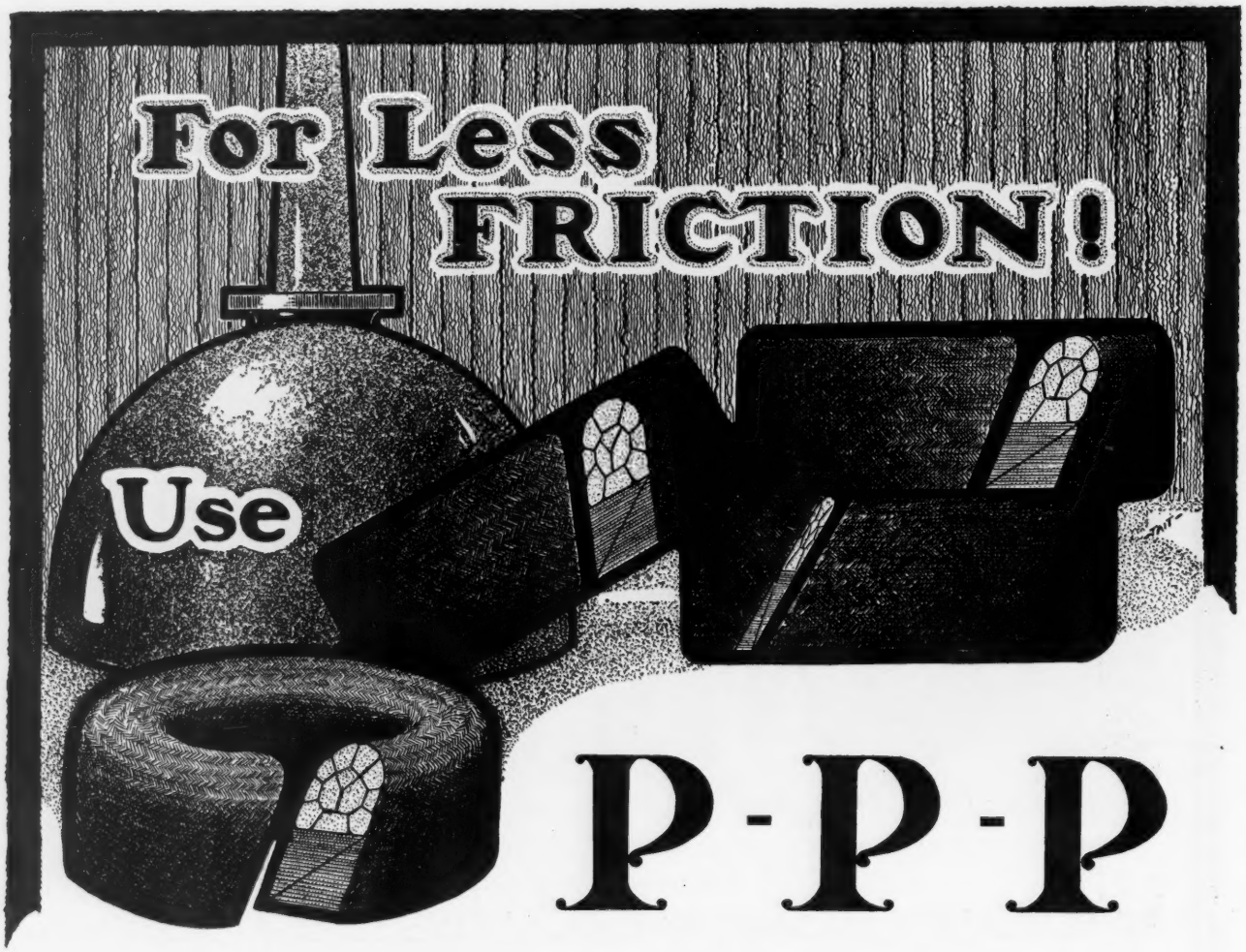

Add to your lubricating equipment P. P. P. Rod Packing!

Then you'll have the one certain combination for overcoming all friction.

However judiciously you may lubricate your engine there still remains friction in the stuffing-box, where no oil or grease has a lasting effect.

Solid Packings (old style packings) cause this friction. They everlastingly grip the rod. They have to, to keep it steam-tight. But the friction that results is costly! It runs up your bills for fuel and packing, and runs down your power and patience. How different is P. P. P.! Always varying its pressure with the varying steam pressure, in the cylinder never remaining any tighter than just steam tight. It not only keeps down friction as nothing else will, but preserves the rod and itself from wear.

Less friction—less expense—less labor for you, and more power are the inevitable results of using P. P. P. Our booklet proves it the ideal packing. May we send you a copy?

QUAKER CITY RUBBER CO.

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This is the P. P. P. trade mark. It stands for the **original** and **only genuine** self-setting packing.

It is imperative, therefore, that every engineer looking for better results should look for this trade mark.

It is the engineer's guarantee that he is receiving the best fibrous packing in the world—no exceptions whatever.

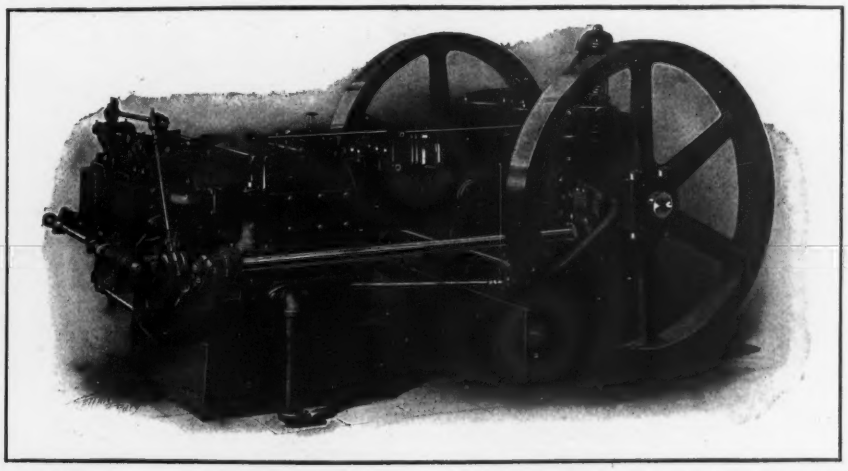
THE BUCKEYE GAS ENGINE

SIMPLE, ECONOMICAL, DURABLE

ESPECIALLY ADAPTED TO DRIVING ELECTRIC GENERATORS

BUILT BY **BUCKEYE ENGINE CO., SALEM, OHIO**

TYPES	POWERS
SINGLE ACTING TWO-STROKE CYCLE	25 H. P. TO 500 H. P.
DOUBLE ACTING TWO-STROKE CYCLE	500 H. P. TO 6000 H. P.
DOUBLE ACTING FOUR-STROKE CYCLE	500 H. P. TO 6000 H. P.



WE STILL MAINTAIN OUR REPUTATION FOR INDEPENDENT THOUGHT AND ACTION AND FOR KEEPING ABREAST OF THE TIMES, AND IN PRESENTING THE BUCKEYE GAS ENGINE, ENGINEERS AND PURCHASERS WILL NOTE THAT WE ARE ORIGINATORS AND LEADERS IN THIS NEW LINE AS WE ALWAYS HAVE BEEN IN OUR STEAM ENGINE PRACTICE.

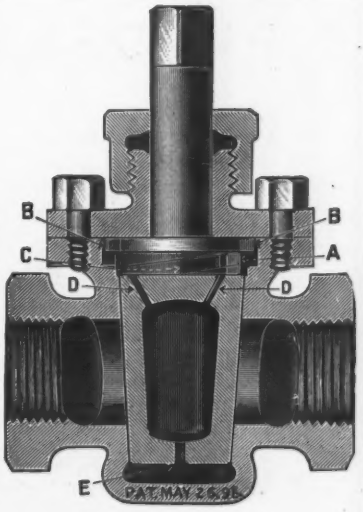
WE CUT FROM NEW CLOTH.

WRITE US WHEN WANTING EITHER GAS OR STEAM ENGINES.

Homestead Valves

COST A LITTLE MORE

than some others at first, but they are worth more and every man knows that the best is the cheapest in the end. Homestead Valves are best because they last longest, cost practically nothing for repairs and gives lest trouble than any other valves on the market. If you have valve troubles, or if you want to avoid them specify the Homestead.



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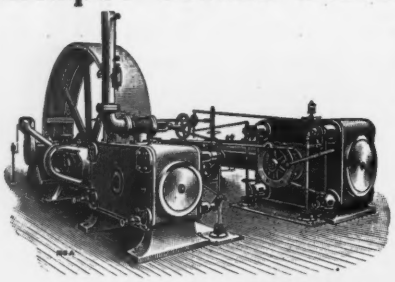
W. A. Case & Son Mfg. Co., Buffalo, N. Y. The F. D. Wallaker Co , Denver, Col.
U. S. Supply Co., Omaha, Neb. Wallace & Gale, Baltimore, Md.
Kansas City Oil and Supply Co., Kansas City, Mo.

Eclipse Corliss Steam Engines



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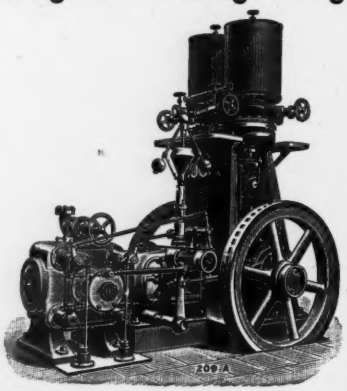

FRICK COMPANY, Waynesboro, Pa., U.S.A.

BUCKEYE ENGINE Co.

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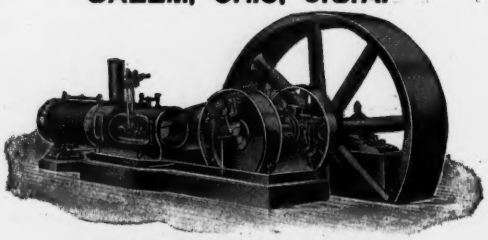

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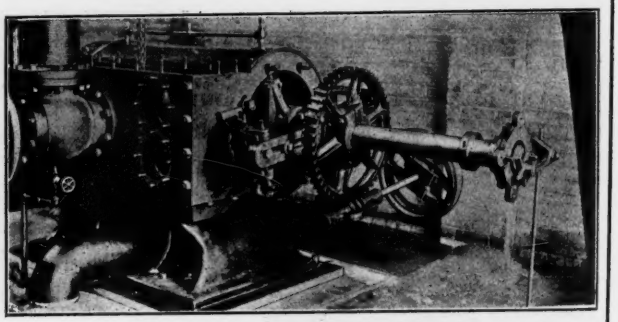


LEES' (PATENTED) IMPROVED PORTABLE BORING TOOL IN POSITION.

With Our Improved Methods and Tools we can repair your engine without removing from foundation and Save Hours of Shut-Down

ENGINES ADJUSTED

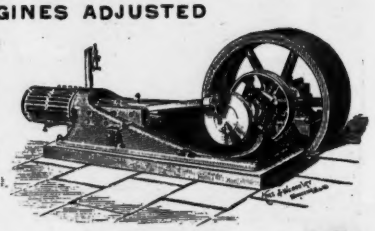
Hartford Engine Works

HARTFORD, CT.

Successors to

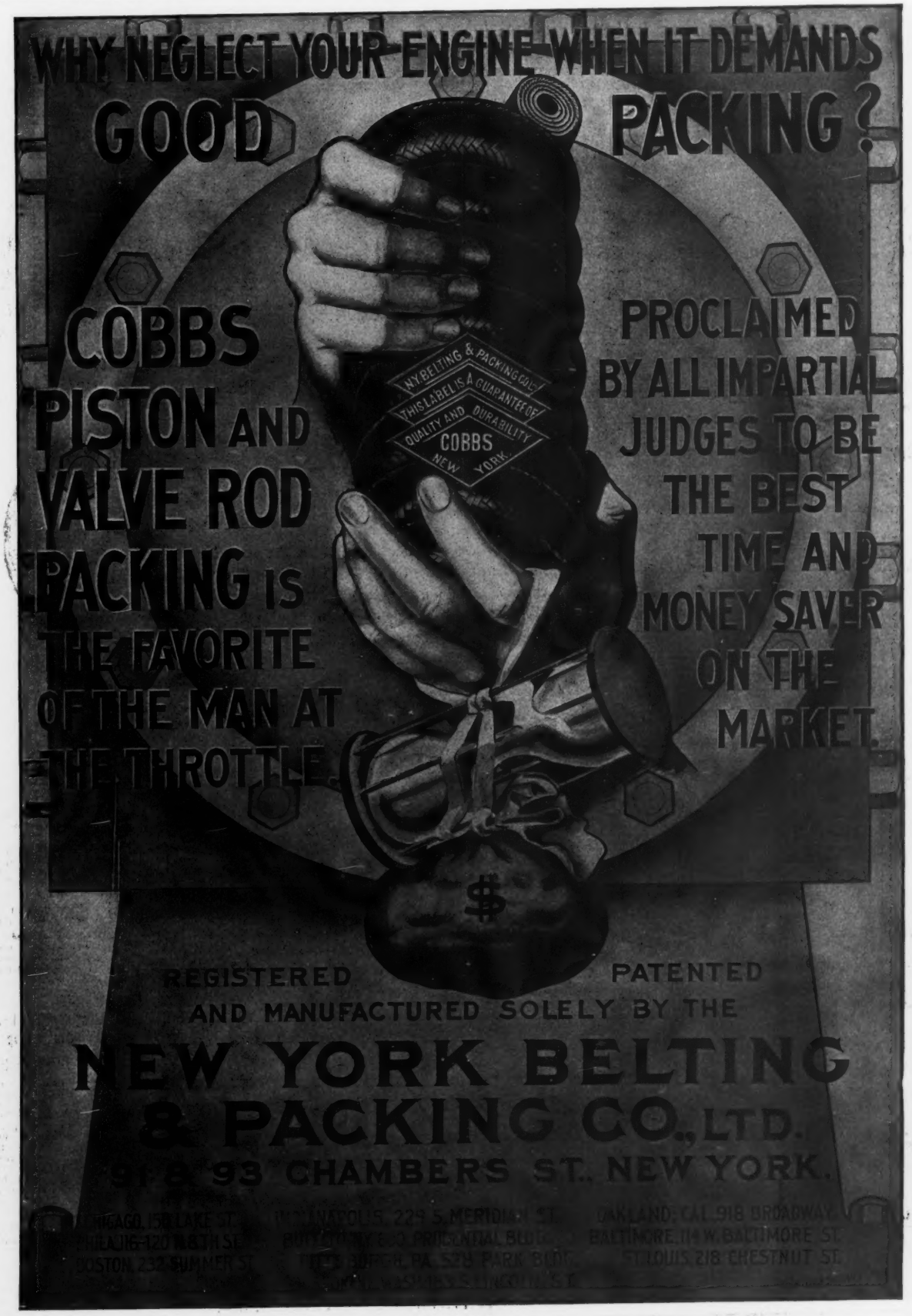
Hartford Engineering Company

Builders of the IMPROVED HARTFORD BUCKEYE ENGINES



We have the drawings and patterns and keep a line of repairs finished and part finished on hand for

Hartford, Buckeye, and Woodruff & Beach Engines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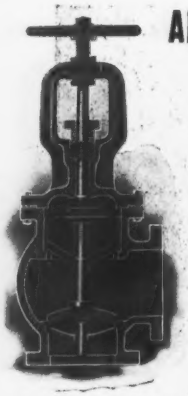


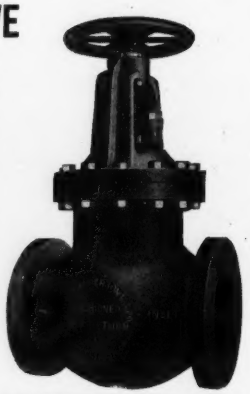
XX EXTRA HEAVY

ANDERSON PATENT CUSHIONED NON-RETURN VALVE

PROTECT YOUR BOILERS WITH AN ABSOLUTE SAFETY STOP

These Valves, when placed between the boiler and header, Equalize the pressure between the Different Units of a battery of boilers, as they remain Closed as long as the boiler pressure is Lower than that of the Header. When the boiler pressure Equals that of the head pressure, they Open and remain in that position without Chattering or Hammering. They automatically cut off a boiler in case of accident to boiler, such as bursting of a tube, and also act as a Safety Stop to prevent steam being turned into a cold boiler, which also means a safeguard for men working inside.

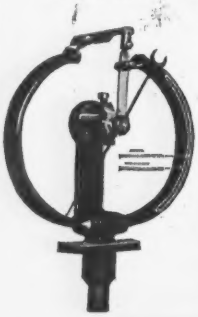
Then why endanger your power plant by using the regular Angle, Globe or Gate Valves at the boilers, when you can get the Anderson Cushioned Non-Return Valve, which is an Automatic Stop Valve, also a Hand Stop Valve, all in one. The sectional cut shows plainly the perfect Dash-pot arrangement for cushioning these valves, which is so Essential in order to avoid the Chattering and Hammering Existing in this class of Valves. The sectional cut also shows the inside Dash-pot attached to the valve spindle, whilst the outside Dash-pot is loose on the spindle, also FREE to move in the body.—in a word, a Corliss Dash-pot, occupying the full area of the body, thus absolutely insuring the perfect cushioning feature and the perfect alignment of the Valve. **"The Valves With a Guarantee," Where is Their Equal?**



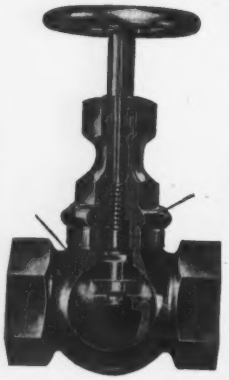
HEAVIEST VALVE MADE

The Golden "NON-CORROSIVE" "NON-SETTING" Steam Gauge

DOUBLE SEAMLESS BRASS AND STEEL DRAWN TUBES



Did you ever see a Steam Gauge with Double Seamless Brass and Steel Drawn Tubes? Here it is the most Accurate and Durable TUBES that have ever been designed for Gauge Service.—A Seamless BRASS TUBE within a Seamless STEEL TUBE, drawn and treated by a Secret Process, making them Non-Corrodible, non-setting, hence they are not effected by Vibration, Shock, or Crystilization that is so ruinous to Gauges. If you want the best and most reliable gauge made; no other gauge will fill your bill. Every tube is tested to 1000 pounds. Write for Special Circular.



Golden "Clean Seat" Valve

The Golden "Clean Seat" Valve

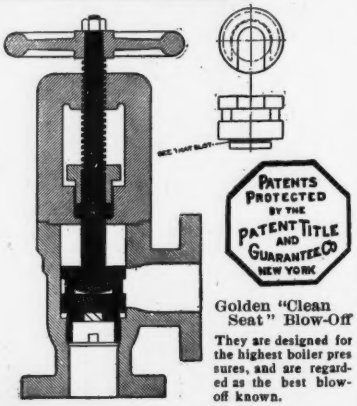
"BUILT FOR SERVICE"

IT CLEANS ITS OWN "SEAT AND DISC"

The bottom of disc is hollow, with solid cast eccentric lugs on the side. Slot or groove is cut between the lugs and entire outside diameter, so when the slot or groove comes flush with seat, steam, water, or air iets direct across the seat and disc. The heaviest, most economical and durable valve made. Also made for Hydraulic and compressed air service.

THE GOLDEN "CLEAN SEAT" BLOW OFF

is as simple and self-cleaning as the Globe and Angle valve. Body is iron fitted with renewable bronze seat and solid bronze valve or disc, with babbit or other flexible metal insertion that can be quickly refilled if found necessary.



Golden "Clean Seat" Blow-Off

They are designed for the highest boiler pressures, and are regarded as the best blow-off known.

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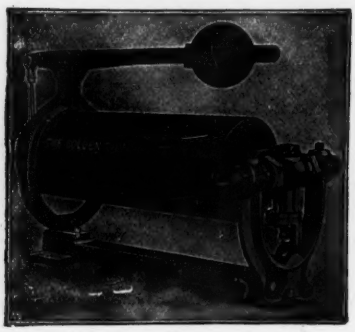
"Simply has no Equal!"

The Valve with an Absolute Guarentee

Cushioned in opening and closing. Float swivels to any angle desired. For high and low pressure. Absolutely controls the water level in tanks or reservoirs. Instantly adjusted to operate quick or slow, as desired. "No waste of water!" The upper portion of body being lined with bronze, also the valve or piston being solid bronze, makes the valve indestructible. Firms that are using them say, "their equal is not made."



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